UNITED STATES DEPARTMENT OF THE INTERIOR, OSCAR L. CHAPMAN, *Secretary*
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LARVAE OF TUNA AND TUNA-LIKE FISHES FROM PHILIPPINE WATERS

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ABSTRACT

The results of the study conducted by the Philippine Fishery Program of the U. S. Fish and Wildlife Service of larval forms of tuna-like fishes collected in Philippine and adjacent seas are recorded.

Five genera, embracing four known species, of larvae previously unknown in the western Pacific are described and illustrated: *Grammatorcynus bicarinatus*, *Neothunnus macropterus*, *Katsuwonus pelamis*, *Euthynnus yaito*, and *Auxis* sp.(?). The distribution and abundance of larvae throughout the year are briefly discussed, and tentative spawning areas are defined. Some evidence of diurnal vertical migration was discovered for all the species except *Grammatorcynus bicarinatus*.

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LARVAE OF TUNA AND TUNA-LIKE FISHES FROM PHILIPPINE WATERS

By CHARLES B. WADE, *Aquatic Biologist*

This is the fourth in a series of papers concerned with the biology and taxonomy of the more common tuna and tuna-like fishes inhabiting Philippine waters. The data for this paper were collected from October 1947 through November 1949 by the biological staff of the Philippine Fishery Program[1] of the Fish and Wildlife Service aboard the oceanographic research vessel *Spencer F. Baird.*

Within an area of 810,000 square miles, and including both the Philippine and closely adjacent seas, 463 tows for larval fish and plankton were made as part of the routine biological operations. Collections were accumulated from off the Island of Celebes (Netherlands East Indies) in the south, to Taiwan (Formosa) in the north, and between 117° and 130° east longitude.

All tows except one (B–37)—a deep oblique haul—were made at the surface. In general the length of each tow was half an hour, although a few 1-hour tows were made (table 1). A standard meter net was used, and the materials collected were preserved in 4-percent formalin solution and returned to the shore laboratory in Manila for sorting and study. There the larval tuna and tuna-like fishes were separated from the mass of zooplankton, and this paper is based on the collection of larval forms.

Despite the abundance of the material collected, 1,842 specimens, the specific identification of many of the specimens could not be made accurately. A great number of specimens were less than 6 millimeters in length, and few characters were sufficiently developed to be used as criteria for identification. Large larval forms of 10 to 15 mm. in length are still unknown for many species, and until these can be collected and identified, accurate segregation of the smaller specimens is not possible.

The monotonous task of sorting the collections was performed capably by Godofredo Mijaro, laboratory technician. Dr. Hilary J. Deason, Chief, Office of Foreign Activities, Fish and Wildlife Service, advised on the preparation of the final text.

LARVAL-FISH AND PLANKTON TOWS

Tows for larval fish and plankton were made during 18 of the 29 months, or 62 percent of the time the *Spencer F. Baird* was stationed in Philippine waters. A station list is given in table 1. Field work began in October 1947, and 36 tows were made during the remainder of that year. Fifty-five percent, or 20 of these tows, produced 219 larval tuna-like fishes. The average number of tuna-like larvae collected per tow during 1947 was 6.1 specimens. Operations were carried on for 7 months during 1948. There were 152 tows during the year of which 50 tows (32.8 percent) produced 251 tuna-like larvae. The average catch for all tows in 1948 was 1.65 larvae. During 9 months of 1949, 112 tows (40.8 percent of the 275 tows) produced 1,372 larval tuna-like fishes. The 1949 average catch for all tows was 4.99 fish. During the entire period of field work, 463 larval fish and plankton tows were made, and 192 (41.5 percent) of these produced larval tuna-like fishes. A total of 1,842 larvae were collected, an average of 3.97 fish per tow for all operations. The monthly catches are shown in table 2.

[1] Part of the Philippine Rehabilitation Program authorized by the Philippine Rehabilitation Act of 1946, title 50, App. U. S. Code, sec. 1789.

TABLE 1.—*Station list of larval-fish and plankton tows made in Philippine waters, 1947–49, and number of tuna-like larvae found at each station*

Station	Date	Latitude	Longitude	Time of tow	Number of specimens
	1947				
B-5	17 Sept.	13°57′ N.	119°30′ E.		
B-15	7 Oct.	11°45′ N.	121°24′ E.	0905–1005	
B-16	do	11°07.5′ N.	121°56′ E.	1605–1705	2
B-17	do	10°13′ N.	121°20′ E.	0100–0200	9
B-18	8 Oct.	10°08′ N.	122°09′ E.	0910–1000	
B-20	do	9°38.5′ N.	121°56.5′ E.	1540–1640	
B-21	do	9°02.5′ N.	122°31′ E.	2300–2400	
B-22	9 Oct.	8°41′ N.	122°50′ E.	0640–0740	1
B-23	do	8°20′ N.	122°47′ E.	1140–1240	
B-24	do	8°14′ N.	122°07.5′ E.	1550–1620	
B-25	10 Oct.	7°27′ N.	121°43′ E.	0109–0134	
B-26	do	7°04′ N.	121°35′ E.	2002–2032	
B-27	11 Oct.	7°45′ N.	121°45′ E.	0237–0252	
B-28	do	8°20′ N.	120°50.5′ E.	1122–1137	
B-29	12 Oct.	6°57′ N.	120°15′ E.	0457–0527	4
B-31	13 Oct.	9°31′ N.	119°40′ E.	(1)	
B-32	do	9°49′ N.	119°22.5′ E.	0455–0525	2
B-33	do	10°19′ N.	120°03′ E.	1145–1215	
B-34	do	10°02′ N.	120°21.8′ E.	1605–1705	5
B-35	do	9°44′ N.	120°38′ E.	2150–2250	16
B-36	14 Oct.	9°08′ N.	121°12.5′ E.	0541–0641	1
B-37	do	8°32′ N.	121°48.5′ E.	1625–1900	1
B-47	3 Dec.	9°03′ N.	118°58′ E.	1851–1951	9
B-48	4 Dec.	8°27.5′ N.	119°34′ E.	0230–0330	
B-49	do	7°51.5′ N.	120°10′ E.	1241–1341	
B-50	do	7°16′ N.	120°45′ E.	2004–2034	16
B-51	5 Dec.	6°57.5′ N.	121°02.5′ E.	0117–0147	3
B-52	do	6°26.5′ N.	120°24′ E.	1022–1122	
B-54	do	6°44′ N.	120°06′ E.	2318–2348	
B-55	6 Dec.	7°08′ N.	119°27′ E.	0620–0720	3
B-56	do	7°54′ N.	118°51′ E.	1347–1447	17
B-57	do	8°32′ N.	118°20′ E.	2128–2228	24
B-58	7 Dec.	8°00.5′ N.	117°40′ E.	0310–0340	46
B-62	9 Dec.	7°27′ N.	118°15′ E.	1306–1336	6
B-64	10 Dec.	6°48.5′ N.	118°51.5′ E.	1957–2105	10
B-65	11 Dec.	5°57.5′ N.	119°09′ E.	0245–0315	14
B-66	do	5°57′ N.	119°39.5′ E.	0730–0830	30
	1948				
B-94	19 Feb.	7°45.75′ N.	122°06.6′ E.	1220–1250	
B-101	23 Feb.	7° N.	123°49′ E.	2010–2110	15
B-102	24 Feb.	6° N.	124° E.	0930–1000	
B-103	do	4°55′ N.	124°05′ E.	1850–1920	
B-104	25 Feb.	4°58′ N.	124°48′ E.	0232–0302	
B-106	do	4°48′ N.	125°30′ E.	1156–1226	
B-108	do	5° N.	126° E.	(2)	
B-109	26 Feb.	6° N.	125°48′ E.	0435–0505	
B-110	do	6°10′ N.	126°15′ E.	1000–1030	
B-112	do	6°22′ N.	125°53′ E.	1525–1555	1
B-113	do	6°44′ N.	125°26′ E.	2026–2056	
B-117	1 Mar.	5°18′ N.	125°30′ E.	0150–0220	
B-118	do	5° N.	126° E.	1100–1130	
B-120	do	3° N.	125° E.	0145–0215	2
B-121	2 Mar.	2° N.	125° E.	0915–0945	
B-123	do	2° N.	126° E.	1755–1825	7
B-124	3 Mar.	3° N.	126° E.	0255–0325	11
B-125	do	4° N.	126° E.	1115–1145	
B-127	do	4° N.	125° E.	2000–2030	1
B-128	4 Mar.	4° N.	124° E.	0337–0407	
B-129	do	3° N.	124° E.	1210–1240	
B-131	do	2° N.	124° E.	2150–2220	
B-133	7 Mar.	1°06.3′ N.	123°59′ E.	0742–0822	7
B-134	do	1°15′ N.	123°12.5′ E.	1726–1756	
B-135	8 Mar.	2° N.	123° E.	0030–0100	
B-136	do	3° N.	123° E.	1002–1032	
B-138	do	4° N.	123° E.	1805–1835	1
B-139	9 Mar.	5° N.	123° E.	0232–0302	1
B-141	do	6° N.	123° E.	2044–2114	
B-150	9 Apr.	3°56′ N.	122°13.5′ E.	0723–0753	
B-151	do	3° N.	122° E.	1635–1705	
B-152	do	2° N.	122° E.	2255–2325	
B-153	10 Apr.	1°14′ N.	122° E.	0555–0625	
B-154	do	1°29′ N.	121° E.	1645–1715	3
B-156	do	2° N.	121° E.	2235–2305	14
B-157	11 Apr.	3° N.	120°55′ E.	0650–0720	3
B-158	do	4° N.	121° E.	1535–1705	
B-160	12 Apr.	3° N.	120° E.	0200–0230	11
B-161	do	2° N.	120° E.	1035–1105	
B-163	do	1° N.	120°05′ E.	2235–2305	
B-164	13 Apr.	00°55′ N.	119°08′ E.	0705–0735	
B-166	do	2° N.	119° E.	1720–1750	
B-167	14 Apr.	3°01′ N.	118°49.5′ E.	0215–0245	
B-168	do	3° N.	118°15′ E.	0950–1020	
B-170	do	4°04′ N.	118°44′ E.	1801–1831	
B-171	15 Apr.	4°08.5 N.	120°06′ E.	0400–0430	4
B-172	do	4°45′ N.	119°54′ E.	1047–1117	

See footnotes at end of table.

TABLE 1.—*Station list of larval-fish and plankton tows made in Philippine waters, 1947–49, and number of tuna-like larvae found at each station*—Continued

Station	Date	Latitude	Longitude	Time of tow	Number of specimens
	1948				
B-173	15 Apr.	4°30′ N.	119°30′ E.	1815–1845	
B-177	16 Apr.	5° N.	120°30′ E.	2330–2400	
B-178	17 Apr.	5°05′ N.	121°04.5 E.	0510–0540	1
B-179	do	5°23′ N.	121° E.	1010–1040	
B-183	19 Apr.	5°12′ N.	121°57′ E.	0612–0642	
B-185	do	6° N.	122° E.	1342–1412	
B-186	do	6°41′ N.	122°23′ E.	1940–2010	
B-187	20 Apr.	7° N.	123° E.	0205–0235	
B-188	do	6°57′ N.	122°25′ E.	0605–0635	
B-240	15 June	12°07′ N.	121°04.5′ E.	1157–1227	
B-242	do	11°56.5′ N.	120°45.5′ E.	1625–1655	
B-243	16 June	11°41′ N.	121°10′ E.	2142–2212	
B-244	do	10°45′ N.	121°48′ E.	0405–0435	
B-246	do	10°32.5′ N.	121°02′ E.	1630–1700	
B-248	do	10°17′ N.	120°12′ E.	0645–0715	
B-249	17 June	9°23′ N.	122°12′ E.	0645–0715	
B-250	do	8°56′ N.	123° E.	1435–1505	
B-252	do	8°36′ N.	123°04′ E.	1842–1912	
B-253	do	8°43′ N.	122°40′ E.	2340–0010	
B-254	18 June	8°14′ N.	122°07.5′ E.	0620–0650	
B-256	do	7°12′ N.	121°05′ E.	1510–1540	
B-258	19 June	6°48′ N.	121°26′ E.	1104–1134	
B-259	do	6°57.5′ N.	129°02.5′ E.	1530–1600	
B-260	do	7°45′ N.	121°25′ E.	2245–2315	
B-261	20 June	8°20′ N.	120°50′ E.	1613–1643	
B-263	do	8°51′ N.	121°03′ E.	1500–1530	
B-264	do	9°27′ N.	120°55′ E.	2300–2330	
B-265	21 June	10°04′ N.	120°22′ E.	0600–0630	
B-267	do	10°19′ N.	120°03′ E.	1021–1051	
B-269	do	9°49′ N.	119°22.5′ E.	1915–1945	
B-270	do	9°31′ N.	119°40′ E.	2335–0005	
B-271	22 June	9°8′ N.	119° E.	0708–0730	
B-273	do	8°27.5′ N.	119° 34′E.	1432–1502	
B-275	do	8°57′ N.	120°15′ E.	2215–2245	
B-279	24 June	7°51.5′ N.	120°10′ E.	0030–0100	
B-280	25 June	7°16′ N.	119°42′ E.	0817–0847	
B-293	10 July	6°44′ N.	120°06′ E.	1330–1400	
B-294	do	6°26.5′ N.	120°24′ E.	1822–1852	
B-295	11 July	5°57′ N.	119°56′ E.	0030–0055	
B-296	do	5°53′ N.	119°23′ E.	0625–0655	
B-298	do	6°17.5′ N.	118°20′ E.	1320–1350	
B-299	do	6°48.5′ N.	118°51.5′ E.	1917–1947	
B-300	12 July	7°27′ N.	118°15′ E.	0320–0357	
B-301	do	7°35′ N.	117°45′ E.	0845–0915	
B-303	do	7°58′ N.	117°11.5′ E.	1555–1625	
B-307	14 July	7°55′ N.	116°42′ E.	1110–1140	
B-308	do	7°12.2′ N.	116°12.5′ E.	1757–1827	
B-309	do	7°26.5′ N.	116°55′ E.	2335–0005	
B-310	15 July	8°32′ N.	118°20′ E.	1422–1452	
B-312	do	7°57′ N.	118°55′ E.	2115–2145	
B-313	16 July	7°21′ N.	119°30.5′ E.	0425–0455	
B-323	29 July	6°57′ N.	122°25′ E.	0803–0833	
B-324	do	6°41.5′ N.	122°24.5′ E.	1055–1125	
B-325	do	6° N.	122° E.	1908–1938	
B-326	30 July	5°23′ N.	121° E.	0650–0720	
B-327	do	5° N.	121° E.	1053–1123	
B-329	do	5° N.	120°30′ E.	1555–1625	
B-330	do	4°45′ N.	119°53′ E.	2130–2200	
B-331	31 July	4°31′ N.	119°30′ E.	0220–0250	
B-332	do	4° N.	120° E.	0930–1000	
B-333	do	4° N.	118°44′ E.	1817–1847	
B-335	1 Aug.	3° N.	118°15′ E.	0242–0312	
B-337	do	3° N.	119° E.	1010–1040	
B-338	do	1°56.5′ N.	119° E.	1802–1832	
B-339	do	1° N.	119°08′ E.	0202–0232	
B-340	2 Aug.	1° N.	119°57′ E.	1205–1235	
B-342	do	2° N.	120° E.	2130–2200	
B-343	3 Aug.	2°56′ N.	120° E.	0550–0620	
B-345	do	4°05′ N.	120°59′ E.	2055–2125	
B-346	4 Aug.	3°04′ N.	120°54.5′ E.	0630–0700	
B-348	do	2° N.	121° E.	1650–1720	
B-349	do	1°29′ N.	121° E.	2142–2212	
B-350	5 Aug.	1°14′ N.	122° E.	0831–0901	
B-352	do	2° N.	122° E.	1536–1606	
B-353	do	3° N.	122° E.	0037–0107	
B-355	6 Aug.	4° N.	122° E.	0845–0915	
B-356	do	5° N.	122° E.	1652–1722	
B-358	7 Aug.	7° N.	123° E.	0910–0940	
B-375	4 Sept.	7° N.	123°49′ E.	2318–2348	
B-376	5 Sept.	6° N.	124° E.	0857–0927	
B-378	do	5° N.	124° E.	1700–1730	
B-379	do	5° N.	125° E.	0243–0313	
B-380	6 Sept.	5°18′ N.	125°30′ E.	0943–1013	
B-382	do	4°48′ N.	125°30′ E.	1430–1500	
B-383	do	5° N.	126° E.	2127–2157	
B-384	7 Sept.	6° N.	125°48′ E.	0607–0637	
B-386	do	6°10′ N.	126°15′ E.	1058–1128	

TABLE 1.—*Station list of larval-fish and plankton tows made in Philippine waters, 1947–49, and number of tuna-like larvae found at each station*—Continued

Station	Date	Latitude	Longitude	Time of tow	Number of specimens
	1948				R
B-387	7 Sept.	6°22′ N.	125°53′ E.	1616–1646	1
B-388	do	6°44′ N.	125°46′ E.	2046–2116	2
B-393	10 Sept.	4° N.	126° E.	0832–0902	
B-395	do	3° N.	126° E.	1703–1733	
B-396	do	2° N.	126° E.	0155–0225	7
B-397	11 Sept.	2° N.	125° E.	1100–1130	
B-399	do	3° N.	125° E.	1945–2015	
B-400	12 Sept.	4° N.	125° E.	0440–0510	2
B-402	do	4° N.	124° E.	1348–1418	
B-403	do	3° N.	124° E.	2355–0025	3
B-404	13 Sept.	2° N.	124° E.	0910–0942	
B-405	do	1°08′ N.	124° E.	1635–1705	2
B-407	do	1°13′ N.	123° E.	0045–0115	2
B-408	14 Sept.	2° N.	123° E.	0900–0930	1
B-410	do	2°30′ N.	123°04′ E.	1550–1620	
B-411	do	2°56′ N.	123°03.5′ E.	2100–2130	4
B-412	15 Sept.	3°53′ N.	123° E.	0624–0654	
B-414	do	5° N.	123° E.	1557–1627	
B-415	do	6° N.	123° E.	0120–0150	9
	1949				
B-476	13 Jan.	14°16′ N.	120°31′ E.	1232–1302	
B-477	do	14° N.	119°50′ E.	2000–2030	
B-479	14 Jan.	14°20′ N.	119°10′ E.	0658–0728	1
B-482	do	14°30′ N.	119°50′ E.	1431–1504	1
B-484	21 Jan.	13°35′ N.	120°07′ E.	2110–2140	25
B-485	22 Jan.	13°24′ N.	119°39′ E.	0230–0300	15
B-486	do	12°42.5′ N.	119°32.5′ E.	0842–0912	4
B-487	do	12°59′ N.	119°56′ E.	1400–1430	1
B-488	do	13°16′ N.	120°21′ E.	1946–2018	4
B-490	23 Jan.	12°50′ N.	120°37′ E.	0257–0327	7
B-492	do	12°32.5′ N.	120°08.5′ E.	1815–1845	1
B-493	do	12°13′ N.	120°33.5′ E.	2255–2325	
B-494	24 Jan.	12°24′ N.	120°52.5′ E.	0217–0247	18
B-495	do	12°07′ N.	121°04.5′ E.	0556–0626	101
B-496	do	11°58′ N.	120°49′ E.	0855–0925	
B-497	do	11°31′ N.	120°39′ E.	1230–1300	2
B-498	do	11°45.3′ N.	121°11.2′ E.	1734–1804	10
B-499	do	11°43′ N.	121°48′ E.	2318–2348	3
B-500	25 Jan.	10°52.5′ N.	121°51.5′ E.	0602–0632	8
B-501	do	10°56′ N.	120°52.5′ E.	1340–1410	3
B-502	do	10°36′ N.	120°37′ E.	1616–1646	13
B-503	do	10°19′ N.	120°03′ E.	2040–2110	34
B-504	26 Jan.	9°49′ N.	119°22.5′ E.	0302–0332	
B-505	do	9°43.5′ N.	118°43.5′ E.	(8)	
B-507	27 Jan.	7°33′ N.	120°29′ E.	0405–0435	1
B-509	28 Jan.	6°21′ N.	118°20′ E.	1650–1720	
B-510	do	6°56′ N.	118°14′ E.	2058–2128	17
B-512	29 Jan.	7°50′ N.	117°08′ E.	0819–0849	
B-515	31 Jan.	7°40.5′ N.	117° E.	0758–0828	1
B-516	do	7°12.5′ N.	116°12.5′ E.	1310–1340	
B-517	do	8°07.5′ N.	116°07′ E.	2232–2302	
B-518	1 Feb.	7°57′ N.	116°31′ E.	0338–0408	2
B-520	do	9°20′ N.	117°03.5′ E.	1410–1440	
B-521	do	9°12′ N.	117°15.5′ E.	1734–1804	
B-522	2 Feb.	10°25′ N.	117°46′ E.	0245–0315	
B-523	do	10°17′ N.	118°06′ E.	0713–0743	1
B-527	3 Feb.	11°03′ N.	119°03′ E.	0740–0810	5
B-528	do	11°22′ N.	118°39.2′ E.	1229–1259	
B-529	do	11°44′ N.	118° E.	1919–1949	307
B-532	14 Feb.	13°47′ N.	120°35′ E.	1604–1634	2
B-533	do	13°35′ N.	120°32′ E.	1905–1935	10
B-534	do	13°37′ N.	120°47′ E.	2210–2240	9
B-535	15 Feb.	13°22′ N.	121°27′ E.	0315–0345	2
B-536	do	13°35′ N.	121°25′ E.	0537–0607	29
B-538	do	13°41′ N.	121°56′ E.	0940–1010	
B-539	do	13°06′ N.	122°06′ E.	1547–1617	
B-540	do	12°37.5′ N.	121°32.5′ E.	1942–2012	302
B-543	16 Feb.	12°17′ N.	121°30′ E.	1004–1034	24
B-544	do	12°06′ N.	121°40′ E.	1307–1337	8
B-545	do	11°55′ N.	121°50′ E.	1540–1610	4
B-546	do	12°10′ N.	122°20′ E.	2157–2227	
B-547	17 Feb.	11°50′ N.	122°36.5′ E.	0220–0250	
B-549	do	11°49.5′ N.	123°12′ E.	0740–0810	
B-550	do	11°15′ N.	123°21.5′ E.	1150–1220	
B-551	do	11°04′ N.	123°48′ E.	1617–1647	1
B-552	do	10°39′ N.	123°42′ E.	1935–2005	14
B-553	do	10°40′ N.	123°32.5′ E.	2130–2200	12
B-554	18 Feb.	9°46′ N.	123°14.8′ E.	0319–0339	3
B-555	do	9°22′ N.	123°27′ E.	0701–0731	
B-556	do	9°40′ N.	123°37.5′ E.	1145–1215	
B-559	19 Feb.	10°23′ N.	124°09′ E.	1205–1235	2
B-560	do	10°40′ N.	124°38′ E.	1918–1948	5
B-563	20 Feb.	11°33′ N.	124°10′ E.	1407–1437	
B-564	do	11°46′ N.	124°39′ E.	1802–1817	
B-567	21 Feb.	11°56′ N.	124°11′ E.	0907–0932	

See footnote at end of table.

TABLE 1.—*Station list of larval-fish and plankton tows made in Philippine waters, 1947–49, and number of tuna-like larvae found at each station*—Continued

Station	Date	Latitude	Longitude	Time of tow	Number of specimens
	1949				
B-568	21 Feb.	12°18′ N.	124°01′ E.	1203–1233	
B-569	21 Feb.	13°07′ N.	124°17′ E.	1926–1956	2
B-570	do	12°55′ N.	124°36.5′ E.	2330–2400	
B-574	23 Feb.	12°37′ N.	123°27.3′ E.	1841–1911	2
B-575	do	12°51′ N.	123°29.5′ E.	2108–2138	
B-576	24 Feb.	12°30′ N.	122°55′ E.	0240–0310	
B-577	do	12°51′ N.	122°47′ E.	0649–0719	2
B-581	25 Feb.	13°24′ N.	122°59′ E.	0943–1013	
B-582	do	13°41.5′ N.	122°41′ E.	1300–1330	
B-655	17 May	18°37′ N.	122°18′ E.	1725–1755	
B-657	do	19°30′ N.	122°40′ E.	0055–0125	
B-659	18 May	20°24′ N.	123°13.2′ E.	0930–1000	
B-661	do	21°19′ N.	123°31′ E.	1807–1837	2
B-663	19 May	20°12.5′ N.	124°18′ E.	0450–0520	
B-667	do	19°11′ N.	125°02′ E.	1520–1550	
B-669	do	18°05′ N.	125°47′ E.	0155–0225	
B-672	20 May	17°45′ N.	124°43′ E.	1030–1100	
B-675	do	17°28′ N.	123°45′ E.	1845–1915	14
B-677	21 May	17°47.5′ N.	122°25′ E.	0525–0555	
B-680	do	17°06.5′ N.	122°36.7′ E.	1430–1500	3
B-682	do	16°14′ N.	122°19′ E.	0030–0100	
B-684	22 May	16°07.5′ N.	122° E.	0445–0515	1
B-686	do	16°13.8′ N.	122°06′ E.	0625–0655	
B-689	23 May	15°18′ N.	121°38′ E.	1845–1915	
B-691	24 May	14°30′ N.	122°04′ E.	0125–0155	7
B-695	do	14°52′ N.	122°28.9′ E.	0805–0835	4
B-696	do	15°35′ N.	124°40′ E.	1425–1455	5
B-698	do	15°52.5′ N.	123°42′ E.	2250–2320	
B-700	25 May	16°02.6′ N.	124°26.8′ E.	0735–0805	
B-703	do	14°49′ N.	124°07′ E.	1800–1830	1
B-705	do	14°19′ N.	123°20′ E.	2400–0030	
B-708	26 May	14° N.	124°36′ E.	1132–1202	
B-710	do	14°40′ N.	125°25′ E.	2048–2118	
B-712	27 May	15°20′ N.	126°12′ E.	0520–0550	
B-716	do	16° N.	126°59′ E.	1413–1443	
B-718	do	15°12′ N.	127°36′ E.	2245–2315	2
B-721	28 May	14°21′ N.	128°15′ E.	0900–0930	1
B-723	do	13°45′ N.	128°51′ E.	1710–1740	
B-725	29 May	12°58′ N.	129°03.2′ E.	0217–0247	
B-728	do	12°31′ N.	128°31′ E.	1030–1100	
B-730	do	12°10′ N.	127°35′ E.	1905–1935	
B-732	30 May	11°50′ N.	126°43′ E.	0300–0330	4
B-735	do	11°31′ N.	125°49′ E.	1153–1223	
B-737	do	12°08′ N.	125°43′ E.	1815–1845	
B-739	do	12°52′ N.	125°20′ E.	0030–0100	
B-741	31 May	13°22′ N.	124°52′ E.	0600–0630	
B-744	do	11°52′ N.	123°48′ E.	1320–1350	
B-748	3 June	10°51′ N.	129°32′ E.	0050–0120	
B-751	4 June	9°48′ N.	129°32′ E.	0940–1010	
B-753	do	8°44′ N.	129°32′ E.	1835–1905	
B-755	5 June	8°32′ N.	129°32′ E.	0353–0423	
B-758	do	7°45′ N.	128°18′ E.	1315–1345	
B-760	do	6°48′ N.	129°27′ E.	0005–0035	
B-763	6 June	5°45′ N.	129°22′ E.	0931–1001	
B-765	do	4°54′ N.	129°17′ E.	1655–1725	
B-767	7 June	5°21′ N.	129°13′ E.	0355–0425	
B-770	do	5°47′ N.	128°16′ E.	1320–1350	
B-772	do	4° N.	127°20′ E.	2130–2200	
B-775	8 June	5° N.	126° E.	1217–1247	
B-777	do	6°16′ N.	126° E.	2040–2110	
B-780	9 June	6°42′ N.	125°46′ E.	0800–0830	
B-782	do	6°50.3′ N.	125°35′ E.	1218–1248	
B-784	do	6°23.7 N.	125°54′ E.	1655–1725	
B-786	do	6°13′ N.	126°02′ E.	2210–2240	
B-788	10 June	7°03′ N.	126°25′ E.	0300–0330	
B-791	do	7°53′ N.	126°44′ E.	0013–0043	
B-794	11 June	5°47′ N.	126°40′ E.	0825–0855	
B-796	do	8°44′ N.	127°20′ E.	1610–1640	2
B-798	do	9°26′ N.	127°23′ E.	2358–0028	
B-801	12 June	9°26′ N.	126°16.3′ E.	0920–0950	
B-803	do	10°18′ N.	126°15′ E.	1548–1618	
B-805	do	10°58′ N.	126°02′ E.	2143–2213	
B-819	18 July	7°12′ N.	116°12′ E.	0510–0540	1
B-821	do	7°57′ N.	116°31′ E.	1215–1245	
B-823	do	8°07.5′ N.	116°07′ E.	1700–1730	5
B-825	19 July	9°20′ N.	117°03.5′ E.	0410–0440	2
B-827	do	9°12′ N.	117°15.9′ E.	0645–0715	3
B-830	do	10°17′ N.	118°06′ E.	1720–1750	1
B-832	do	10°25′ N.	117°46′ E.	2135–2205	13
B-834	20 July	11°22′ N.	118°39.2′ E.	0640–0710	
B-837	do	10°55′ N.	119°18.5′ E.	1325–1355	
B-838	do	10°50.3′ N.	119°22.5′ E.	1445–1515	
B-842	23 July	10°55′ N.	119°18.9′ E.	0750–0820	
B-844	do	11°44′ N.	118° E.	2005–2035	
B-845	24 July	12°05′ N.	117°03′ E.	0610–0640	
B-847	do	12°55′ N.	117°04′ E.	1315–1345	1

TABLE 1.—*Station list of larval-fish and plankton tows made in Philippine waters, 1947–49, and number of tuna-like larvae found at each station*—Continued

Station	Date	Latitude	Longitude	Time of tow	Number of specimens
	1949				
B–849	24 July	12°42′ N.	118°44′ E.	0035–0105	
B–852	25 July	12°52′ N.	119°50′ E.	0820–0850	
B–854	do	13°18′ N.	120°18′ E.	1425–1455	
B–856	do	13°25′ N.	119°50′ E.	2050–2120	
B–859	1 Aug.	14°05′ N.	119°22′ E.	0300–0330	
B–862	do	13°54′ N.	118°37.5′ E.	0945–1015	
B–864	do	13°45′ N.	117°53′ E.	1607–1637	6
B–866	do	13°34′ N.	117°07′ E.	2315–2345	3
B–868	3 Aug.	14°22′ N.	117°08′ E.	0755–0825	4
B–870	do	15°10′ N.	117°11′ E.	1520–1550	
B–872	do	16°02′ N.	117°06′ E.	2245–2315	
B–874	4 Aug.	16°52′ N.	117°18′ E.	0642–0712	
B–877	do	15°57′ N.	118° E.	1610–1640	
B–879	do	15°55′ N.	118°52′ E.	2323–2353	
B–882	5 Aug.	15°05′ N.	119°50′ E.	0823–0853	2
B–884	do	15°53′ N.	119°36′ E.	1700–1730	
B–886	do	16°23′ N.	119°40′ E.	2143–2212	
B–888	6 Aug.	16°21′ N.	120°12′ E.	0225–0255	5
B–891	do	17°22′ N.	120°16′ E.	0950–1020	
B–893	do	17°37′ N.	119°26′ E.	1733–1753	10
B–895	do	17°52′ N.	118°37′ E.	0050–0120	1
B–898	7 Aug.	17°31′ N.	117°27′ E.	1005–1035	
B–900	do	18°08′ N.	117°32′ E.	1513–1543	2
B–902	do	19°03′ N.	118°05′ E.	2222–2252	
B–904	8 Aug.	19°25′ N.	119°09′ E.	1737–1807	
B–907	do	19°58′ N.	118°36′ E.	1545–1615	
B–909	do	20°25′ N.	119°16′ E.	2243–2312	1
B–911	9 Aug.	20°42′ N.	120°04′ E.	0543–0612	1
B–914	do	21°40′ N.	120°50′ E.	1442–1512	
B–916	do	21°03′ N.	120°52′ E.	2007–2037	1
B–918	10 Aug.	20°17.6′ N.	120°52′ E.	0532–0602	
B–921	do	19°32′ N.	120°52′ E.	1158–1228	1
B–923	do	18°49′ N.	120°54′ E.	1940–2010	
B–925	11 Aug.	18°58′ N.	119°47′ E.	0507–0537	1
B–928	do	18°25′ N.	120°23.8′ E.	1140–1210	
B–930	do	17°56′ N.	120°11′ E.	1643–1712	4
B–937	25 Aug.	6°02′ N.	120°38′ E.	1530–1600	
B–939	do	5°33′ N.	120°14′ E.	2006–2036	
B–941	do	5°46′ N.	119°52′ E.	2400–0030	1
B–943	26 Aug.	5°10′ N.	119°25′ E.	0513–0543	135
B–946	do	5°01.5′ N.	119°38′ E.	0753–0823	10
B–948	do	6° N.	119°15′ E.	0107–0137	2
B–950	27 Aug.	6°39′ N.	118°47′ E.	0645–0715	
B–953	do	7°23.5′ N.	118°33′ E.	2232–2302	
B–955	28 Aug.	7°21′ N.	119°31′ E.	0517–0547	
B–958	do	7°48′ N.	120° E.	1050–1120	
B–960	do	8° N.	119° E.	1752–1822	
B–962	do	8°26′ N.	119°20′ E.	2145–2215	
B–964	29 Aug.	8°20.5′ N.	118°14′ E.	0525–0555	
B–967	do	9°04′ N.	118°40′ E.	1138–1208	1
B–969	do	9°50′ N.	119°13′ E.	1740–1810	
B–971	30 Aug.	10°19′ N.	120°15′ E.	0110–0140	
B–974	do	9°13′ N.	121° E.	0840–0910	1
B–976	do	9°09′ N.	120°04′ E.	1553–1623	1
B–980	1 Sept.	8°21′ N.	121° E.	1205–1235	
B–982	do	7°14′ N.	120°43′ E.	2010–2040	
B–984	2 Sept.	6°45′ N.	120°07′ E.	0206–0236	
B–987	do	7° N.	121°29′ E.	1225–1255	
B–989	3 Sept.	7°04′ N.	121°51′ E.	1921–1951	
B–991	4 Sept.	8°15′ N.	122°29′ E.	0145–0215	1
B–993	do	8°37′ N.	123°04′ E.	0705–0735	1
B–996	do	9° N.	123°03′ E.	1025–1055	1
B–998	do	8°53′ N.	121°47′ E.	1910–1940	1
B–1000	5 Sept.	9°31′ N.	122°15′ E.	0040–0110	7
B–1003	do	10°27′ N.	121°51′ E.	0915–0945	5
B–1005	do	10°21′ N.	121°11′ E.	1440–1510	6
B–1007	do	11°44′ N.	121°48′ E.	0035–0105	1
B–1009	6 Sept.	11°40′ N.	121°11′ E.	0532–0602	
B–1012	do	12°35′ N.	120°50′ E.	1234–1304	
B–1014	do	12°31′ N.	120°23′ E.	1625–1655	
B–1016	12 Sept.	13°37′ N.	120°37′ E.	2215–2245	
B–1018	13 Sept.	13°30′ N.	121°31′ E.	0504–0534	
B–1022	do	12°30′ N.	121°45′ E.	1220–1250	3
B–1024	do	12°06′ N.	122°22′ E.	1930–2000	
B–1028	14 Sept.	12°55′ N.	122°30′ E.	1630–1700	17
B–1030	do	13°29′ N.	122°55′ E.	2155–2225	
B–1031	15 Sept.	12°33′ N.	123°33′ E.	0609–0639	
B–1034	do	13°07′ N.	124°18′ E.	0030–0100	2
B–1035	16 Sept.	13°08′ N.	124°05′ E.	0310–0340	
B–1038	17 Sept.	11°49′ N.	124°10′ E.	2200–2230	
B–1040	18 Sept.	10°44′ N.	125°19′ E.	2212–2242	8
B–1042	19 Sept.	9° N.	124°39′ E.	1735–1805	1
B–1043	do	9°35.5′ N.	124°29.2′ E.	2107–2137	
B–1045	20 Sept.	9°05′ N.	123°50′ E.	0415–0445	
B–1046	do	8°50′ N.	123°57′ E.	0855–0925	1
B–1048	21 Sept.	9°49′ N.	123°15′ E.	0120–0150	
B–1050	22 Sept.	10°02′ N.	123°45′ E.	1450–1520	

TABLE 1.—*Station list of larval-fish and plankton tows made in Philippine waters, 1947–49, and number of tuna-like larvae found at each station*—Continued

Station	Date	Latitude	Longitude	Time of tow	Number of specimens
	1949				
B–1051	22 Sept.	10°52′ N.	124°12′ E.	2240–2310	1
B–1053	23 Sept.	11°14′ N.	123°19′ E.	0905–0935	
B–1057	12 Oct.	13°09′ N.	125°13′ E.	2350–0020	1
B–1060	13 Oct.	14° N.	124°49′ E.	1330–1400	
B–1071	16 Oct.	13°38′ N.	128°30′ E.	1445–1515	
B–1072	do	13°12′ N.	127°35′ E.	2230–2300	
B–1075	17 Oct.	12°18′ N.	125°44′ E.	1415–1445	
B–1076	do	11°25′ N.	126°07′ E.	2145–2215	1
B–1077	18 Oct.	10°33′ N.	126°26′ E.	0505–0535	1
B–1079	do	10°43′ N.	127°29′ E.	1333–1403	
B–1080	do	10°55′ N.	128°27′ E.	2020–2050	3
B–1081	19 Oct.	11°07′ N.	129°27′ E.	0515–0545	1
B–1083	do	12°14′ N.	130°12′ E.	1450–1520	1
B–1084	do	11°20′ N.	130°36′ E.	2325–2355	
B–1085	20 Oct.	10°28′ N.	130°37′ E.	0620–0650	
B–1087	do	9°38′ N.	130°38′ E.	1317–1347	
B–1088	do	8°44′ N.	130°39′ E.	2005–2035	
B–1089	21 Oct.	8°44′ N.	129°40′ E.	0440–0510	
B–1091	do	8°44′ N.	128°40′ E.	1120–1150	
B–1092	do	8°44′ N.	127°38′ E.	1900–1930	1
B–1093	do	8°44′ N.	126°38′ E.	0405–0435	
B–1095	22 Oct.	9°44′ N.	126°38′ E.	1420–1450	
B–1105	16 Nov.	12°49′ N.	124°24′ E.	1530–1600	1
B–1106	17 Nov.	14° N.	126°20′ E.	1105–1135	
B–1108	18 Nov.	12°10′ N.	124°06′ E.	0936–1006	3
B–1110	do	11°38′ N.	128°38.5′ E.	1540–1610	1
B–1111	19 Nov.	11°23.5′ N.	123°20.7′ E.	0645–0715	1
B–1113	do	11°39′ N.	123°02′ E.	1050–1120	2
B–1114	do	11°56′ N.	123°19′ E.	1425–1455	7
B–1115	20 Nov.	12° N.	122°40′ E.	0845–0915	
B–1117	do	11°33′ N.	120°51′ E.	1430–1500	7
B–1118	21 Nov.	10°45′ N.	120°40′ E.	0645–0715	6
B–1120	do	11°21′ N.	120°02′ E.	1255–1325	
B–1121	do	11°24′ N.	119°37.5′ E.	1630–1700	
B–1123	22 Nov.	10°55′ N.	119°18.3′ E.	1255–1325	
B–1124	do	11°06′ N.	118°59′ E.	1615–1645	
B–1125	23 Nov.	13° N.	118° E.	0725–0755	
B–1127	24 Nov.	13°31′ N.	119°51.2′ E.	[4]	
B–1129	do	14°30′ N.	120°45′ E.	1605–1635	

[1] Canceled, mechanical trouble.
[2] Sample not taken.
[3] Tow not taken.
[4] Contents not preserved.

The greatest number of tows were made during the month of August. Of 67 hauls, 29 (43.3 percent) were successful. A total of 256 tuna-like larvae was taken, and the average catch for all tows made during August was 3.82 fish. The fewest tows (15) were made during December, with a total of 178 specimens taken in 73.3 percent (11 stations) with an average of 11.8 specimens.

In terms of the number of larvae captured, June was the poorest month. Only 14 specimens were taken in 9 (17.3 percent) of 52 hauls, and the average catch for all tows was 0.27 larvae. The greatest number of larvae were taken in February, when 5 tows resulted in the capture of 764 tuna-like larvae. The number of successful tows was 24 (45.3 percent of the total operations, and the average catch for all tows was 14.38 fish.

Based on the number of tuna-like larvae collected, December, January, and February are the months of most intensive spawning activity. During these

months, 1,212 larvae were taken in 98 tows. Fifty-six tows (57.1 percent) were successful, with an average of 12.3 specimens per tow for all operations. The number of specimens taken during these 3 months represented 65.8 percent of all specimens captured.

TABLE 2.—*Monthly catch of larval tuna and tuna-like fishes taken by larval-fish and plankton tows in Philippine waters, 1947–49*

Date	Total plankton tows	Plankton tows with tuna larvae		Larvae	
		Number	Percent	Total number	Average catch per tow
1947					
October	21	9	42.8	41	1.95
December	15	11	73.5	178	11.90
1948					
February	10	2	20.0	16	1.60
March	18	7	38.9	30	1.66
April	27	10	37.0	53	1.96
June	27	8	29.6	12	.44
July	25	8	32.0	21	.84
August	17	8	47.0	63	3.70
September	28	17	60.7	56	2.00
1949					
January	30	21	70.0	270	9.00
February	43	22	51.1	748	17.4
May	38	10	26.3	40	1.05
June	25	1	4.0	2	.08
July	18	7	38.9	26	1.44
August	50	21	42.0	193	3.86
September	35	15	42.8	56	1.57
October	20	7	35.0	9	.45
November	16	8	50.0	28	1.75
All	463	192	41.5	1,842	3.97

From this peak of abundance, the number of larvae taken decreased rapidly in March, then gradually declined to its ebb in June. Following the June ebb, the number of larvae captured again increased until a small peak of abundance was reached in August. The number of larvae collected again decreased during the months of September, October, and November.

The distribution of the catch of larval tuna-like fishes according to the hour of the tow is given in table 3. Plankton tows were not conducted at specified times, but usually after each hydrographic station had been occupied. For comparison, day has been designated from 0600 to 1800 hours, and night from 1800 to 0600 hours.

During the daylight hours 250 plankton tows were made, and 212 were made at night. Tuna-like larvae were taken in 87 (34.8 percent) of the day tows and 105 (49.5 percent) in the night hauls. Many more larvae were taken at night than during the day: 1,395 larvae (75.8 percent of the total number) were taken at night, and only 447 (24.2 percent) collected during the day. The average number of specimens from each day tow was 1.78, and from each night tow, 6.58.

TABLE 3.—*Hourly summary of tuna and tuna-like larvae collected in Philippine waters, 1947–49*

Hour	Total plankton tows	Plankton tows with tuna larvae		Larvae	
		Number	Percent	Total number	Average catch per tow
0600–0659	26	9	34.6	126	4.86
0700–0759	18	9	50.0	22	1.22
0800–0859	19	9	47.3	57	2.95
0900–0959	23	7	30.4	13	.56
1000–1059	15	4	26.6	26	1.73
1100–1159	18	3	16.7	4	.22
1200–1259	22	4	18.2	8	.36
1300–1359	19	4	21.0	18	.95
1400–1459	21	8	38.0	50	2.38
1500–1559	16	7	43.7	12	.75
1600–1659	31	14	45.1	59	1.90
1700–1759	22	9	40.9	52	2.36
1800–1859	16	11	68.7	34	2.12
1900–1959	21	10	47.5	657	31.20
2000–2059	16	8	50.0	84	4.62
2100–2159	23	11	47.8	116	5.05
2200–2259	21	8	38.0	46	2.47
2300–2359	17	6	35.3	19	1.12
0000–0059	18	8	44.5	32	1.72
0100–0159	13	8	61.5	29	2.13
0200–0259	21	10	47.6	80	3.80
0300–0359	15	9	60.0	101	6.75
0400–0459	13	6	46.1	12	.92
0500–0559	18	10	55.5	185	10.25

The average catch per hour varied considerably—the most productive hour being from 1900 to 2000 when an average of 31.2 larvae were taken in each tow. Two abnormally large catches, B–529 and B–540, appear to have distorted this average catch, and if they are omitted from the total, the average becomes 2.28 specimens per tow, which conforms more closely to the mean catch of the adjacent hours.

The least productive period during the day was from 0900 to 1600 hours. The average catch per tow during this period was 0.98 larvae, and only 27.6 percent of the 134 tows captured specimens. Early morning, from 0600 to 0700 hours, was the most productive period during the day. An average of 4.86 fish were taken in each of the 26 tows made at this time; 34.6 percent of the tows captured specimens.

The least productive period during the night was from 2300 to 0100 hours, when an average of only 1.45 larvae was obtained in 35 tows; 40 percent of the tows were productive. Disregarding the two apparently abnormally large catches made during the 1900 hour, two periods of large catches occurred during the night. The first occurred from 2000 to 2200 hours, when 200 larvae were taken in 39 tows. The average number per tow was 5.13, with specimens taken in 48.7 percent of total operations. The

second period occurred from 0200 to 0600 hours, when 378 larvae were taken for an average catch of 5.65 fish per tow. During this period 67 tows were made, and 35 (52.2 percent) caught specimens.

Night is not only more productive of specimens, but from the increase in percentage of successful tows, it also seems that the larvae are more widely distributed. Furthermore, there is a considerable vertical migration downward during the day and a return to the surface at night. Since no tows were made beneath the surface, the depth to which tuna-like larvae descend is not known.

Although the exploratory nature of the program over an extensive area precluded the periodic reexamination of any specific area for fluctuations in abundance of tuna-like larvae, sufficient data were collected from 6 irregularly timed trips to the Sulu Sea to indicate possible trends in annual abundance (table 4). Tuna-like larvae were taken in the greatest abundance during December and January, when averages of 11.9 and 12 specimens, respectively, were taken in each haul. The least productive months were June and July, with average catches of 0.44 and 0.66 larvae, respectively.

TABLE 4.—*Summary of larval-fish and plankton tows made during six cruises to the Sulu Sea, 1947–49.*

Month	Total number of tows	Successful tows		Catch, tuna-like larvae		Average surface temperature (centigrade)
		Number	Percent	Total number	Average, all tows	
Jan. 24–31, 1948	16	11	68.8	192	12.00	26.51°
Mar. 22–29, 1949	15	(1)				27.33°
June 15–25, 1948	27	8	29.6	12	.44	29.74°
July 10–16, 1948	15	4	26.7	10	.66	29.28°
Aug. 25–Sept. 6, 1949	32	13	40.1	39	1.22	29.05°
Oct. 7–13, 1947	21	9	42.8	44	1.95	29.30°
Dec. 3–11, 1947	15	11	73.5	178	11.86	28.76°

[1] Biological data not collected during this trip; this entry is included for the surface temperature record.

The surface water temperatures during the trips (table 4) varied from a low of 26.51 °C. in January to 29.74 °C. in June, a range of 3.23 °C. It should be noted that although the temperatures in general were high, the greatest number of tuna-like larvae was collected during the period of lowest temperatures, December and January. The significance of this fact, if any, is not known, but the possibility that the peak of spawning occurs during the period of low temperature should be investigated more completely.

No attempt is made to discuss the ecology of the tuna-like larvae either as a group or by species. These ecological relationships must necessarily await the final analysis of the hydrographic data obtained simultaneously. However, the data of temperature (°C), salinity (°/oo), and phosphates (ug-at/L), as recorded at the surface during each larval-fish and plankton tow, are given in table 5 and contain sufficient information to be of value to future research in this field.

TABLE 5.—*Surface conditions, physical and chemical, at larval-fish and plankton tow stations*

Station No.	Temperature (°C.)	Salinity (o/oo)	Phosphate-P (ug-at/L)	Station No.	Temperature (°C.)	Salinity (o/oo)	Phosphate-P (ug-at/L)
B-5				B-158	29.07	34.27	0.10
B-15	28.87	33.62	0.15	B-160	28.78	34.27	.10
B-16	29.30	32.77	.15	B-161	29.36	34.09	.07
B-17	28.99	33.84	.15	B-163	29.71	34.07	.10
B-18	28.99	33.84	.15	B-164	28.86	33.66	.07
B-20	29.71	33.80	.05	B-166	29.73	34.25	.08
B-21	29.09	33.71	.05	B-167	29.26	34.34	.15
B-22	29.10	33.82	.10	B-168	29.23	34.31	.10
B-23	29.75	33.66	.05	B-170	29.16	34.13	.07
B-24	29.60	33.84	.05	B-171	28.61	34.29	.05
B-25	29.36	33.93	.05	B-172	29.19	34.25	.05
B-26	29.86	33.84	.10	B-173	29.53	34.33	.05
B-27	29.25	33.84	.05	B-177	28.90	34.23	.03
B-28	30.27	33.77	.05	B-178	28.52	34.34	.05
B-29	29.14	33.49	.05	B-179	28.60	34.33	.05
B-31	28.72	33.51	.05	B-183	28.57	34.29	.15
B-32	29.23	33.22	.05	B-185	29.31	34.20	.05
B-33	29.30	33.19	.05	B-186	29.22	34.20	.10
B-34	29.51	33.57	.05	B-187	29.32	34.20	.07
B-35	28.76	33.57	0	B-188	29.26	34.16	.10
B-36	29.03	33.78	.05	B-240	29.94	34.13	.20
B-37	29.51		.05	B-242	30.21	33.73	.13
B-47	28.58	33.26	.20	B-243	30.00	34.11	.10
B-48	28.53	33.58	.10	B-244	29.88	34.07	.08
B-49	28.71	33.98	.05	B-246	30.62	34.02	.10
B-50	28.98	33.06	.03	B-248	30.35	34.20	.10
B-51	28.70	33.08	0	B-249	29.90	34.20	.10
B-52	28.73	33.06	0	B-250	29.68	34.23	.10
B-54	29.08	33.24	0	B-252	30.23	33.86	.05
B-55	28.87	33.87	.05	B-253	30.11	34.09	.05
B-56	28.84	34.02	.05	B-254	29.82	34.02	.05
B-57	28.75	33.96	0	B-256	29.77	33.93	.10
B-58	28.58	33.37	0	B-258	29.62	34.05	.10
B-62	28.97	33.42	.05	B-259	29.85	33.71	0
B-64	28.58	33.49	.05	B-260	29.73	33.91	.05
B-65	28.63	33.13	0	B-261	29.74	34.09	.0
B-66	28.82	33.35	0	B-263	29.37	33.98	.0
B-94				B-264	29.49	34.14	.1
B-101	27.95	34.18	.08	B-265	29.37	34.16	.0
B-102	28.65	34.05	0	B-267	29.26	34.20	.0
B-103	28.40	34.00	.05	B-269	29.30	34.25	.1
B-104	27.39	34.22	0	B-270	29.54	34.18	.1
B-106	27.39	34.24	0	B-271	29.23	34.14	.0
B-108				B-273	29.48	34.02	.0
B-109	26.86	34.51	0	B-275	29.51	34.14	.1
B-110	27.25	34.65	.15	B-279	29.57	34.09	.0
B-112	27.09	34.40	.05	B-280	29.58	34.07	.0
B-113	26.87	34.42	.05	B-293	29.74	34.05	0
B-117	27.31	34.43	.05	B-294	29.66	34.09	.0
B-118	27.59	34.31	.05	B-295	29.01	34.09	.0
B-120	27.75	34.14	0	B-296	28.85	33.96	.1
B-121	27.54	34.07	0	B-298	29.55	33.13	0
B-123	28.08	33.95	0	B-299	29.28	33.10	0
B-124	27.39	34.18	.10	B-300	29.21	32.63	0
B-125	27.69	34.40	0	B-301	29.25	32.70	.0
B-127	27.49	34.40	.10	B-303	29.28	32.57	.0
B-128	27.98	34.25	.05	B-307	29.11	32.63	.0
B-129	28.36	33.80	.05	B-308	29.35	32.21	.0
B-131	28.20	33.93	.05	B-309	29.69	31.74	.0
B-133	28.14	33.80	0	B-310	29.38	32.61	.0
B-134	28.98	33.89	.05	B-312	29.07	33.62	.0
B-135	28.59	33.87	.05	B-313	28.78	33.6	.0
B-136	28.45	34.05	.05	B-323	29.31	33.44	0
B-138	28.56	34.07	.10	B-324	29.11	33.46	.0
B-139	27.90	34.25	.05	B-325	29.05	33.86	0
B-141	28.77	34.13	.10	B-326	29.06	34.05	.0
B-150	28.97	33.89	.05	B-327	29.21	34.09	.0
B-151	29.61	34.29	.05	B-329	29.58	34.16	0
B-152	28.83	34.31	.05	B-330	29.33	34.09	.1
B-153	28.78	34.09	.05	B-331	28.91	33.80	0
B-154	29.33	34.09	.05	B-332	29.27	34.13	0
B-156	29.24	34.22	.05	B-333	29.40	34.05	.0
B-157	28.66	34.29	.05	B-335	28.91	34.05	.0

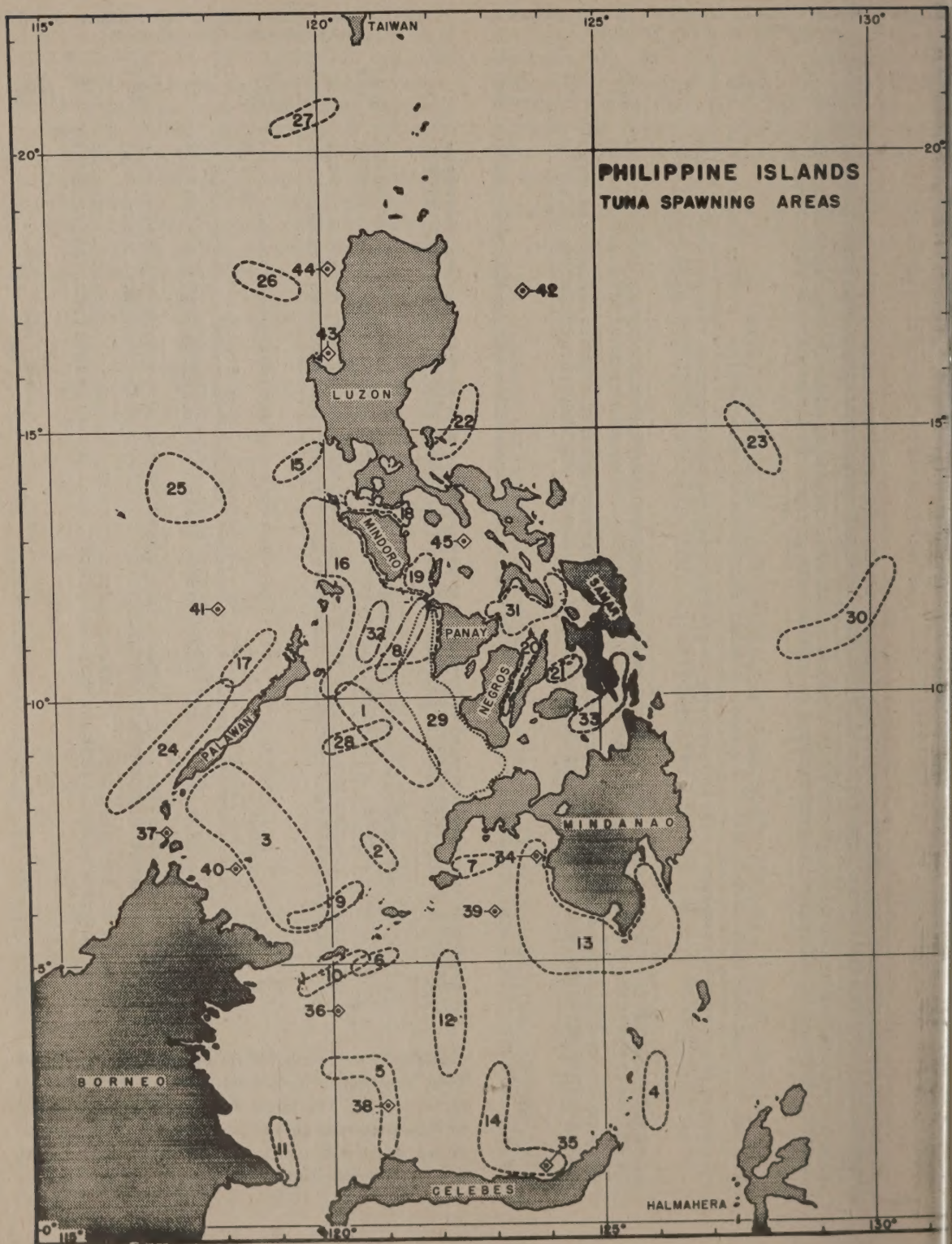
TABLE 5.—*Surface conditions, physical and chemical, at larval-fish and plankton tow stations*—Continued

Station No.	Temperature (°C.)	Salinity (o/oo)	Phosphate-P (ug-at/L)
B-337	29.27	34.09	0.05
B-338	29.24	34.09	.05
B-339	28.57	33.91	.05
B-340	28.99	34.09	.10
B-342	29.51	34.09	.05
B-343	29.33	34.13	.05
B-345	29.80	34.16	.05
B-346	29.15	34.11	.05
B-348	30.05	34.05	.15
B-349	29.88	34.04	.15
B-350	28.97	34.05	.15
B-352	29.59	34.09	.05
B-353	29.35	34.23	.08
B-355	29.04	34.20	.15
B-356	29.83	34.22	.15
B-358	29.78	33.33	0
B-375	28.67	33.46	0
B-376	28.61	33.89	.10
B-378	29.28	33.84	0
B-379	28.55	34.25	.07
B-380	28.50	34.29	.05
B-382	28.79	34.27	.10
B-383	28.73	34.27	.07
B-384	28.54	34.18	.10
B-386	29.51	34.29	.10
B-387	29.81	34.09	.08
B-388	29.00	33.86	.10
B-393	28.54	34.25	0
B-395	28.41	34.22	.05
B-396	27.68	34.13	.15
B-397	28.75	34.18	0
B-399	29.23	34.22	.05
B-400	28.87	34.27	.10
B-402	28.90	34.27	.05
B-403	28.95	34.16	.05
B-404	28.89	34.13	.05
B-405	28.95	34.14	.10
B-407	28.77	34.16	.10
B-408	28.91	34.16	.08
B-410			
B-411	28.95	34.16	.12
B-412	28.73	34.25	.10
B-414	28.53	34.33	.15
B-415	28.59	33.86	.02
B-476	26.43	32.84	0
B-477	26.83	32.97	.05
B-479	26.64	32.90	0
B-482	27.27	33.06	0
B-484	26.35	33.49	.05
B-485	25.35	33.87	.10
B-486	26.03	33.49	.10
B-487	26.22	33.60	0
B-488	26.27	33.51	0
B-490	26.74	33.49	.05
B-492	27.12	33.40	0
B-493	26.91	33.44	.05
B-494	26.49	33.64	0
B-495	25.89	33.80	.05
B-496	26.28	33.46	.05
B-497	26.04	33.73	.05
B-498	26.12	33.64	.15
B-499	25.75	33.93	.12
B-500	26.54	33.82	.05
B-501	25.98	33.93	.05
B-502	25.85	33.93	.05
B-503	26.23	33.89	0
B-504	26.97	33.75	0
B-505		33.82	.05
B-507	27.40	33.82	.05
B-509	27.40	33.82	.05
B-510	27.13	33.87	.05
B-512	27.07	33.62	0
B-515	26.98	33.80	.15
B-516	26.52	33.35	.10
B-517	26.43	33.37	.10
B-518	26.43	33.35	.10
B-520	26.84	33.53	.10
B-521	26.59	33.60	0
B-522	26.92	33.21	.05
B-523	26.12	33.49	0
B-527	26.55	33.49	.10
B-528	27.18	32.99	0
B-529	27.07	33.13	.10
B-532	26.31	33.69	.10
B-533	27.00	33.49	0
B-534	26.52	33.57	.05
B-535	26.51	33.82	.04
B-536	26.22	33.96	.05
B-538	26.36	34.11	0.08
B-539	26.71	34.22	.05
B-540	26.14	34.09	.05
B-543	26.32	34.13	.05
B-544	25.93	34.09	.10
B-545	25.03	34.11	.15
B-546	26.12	34.09	.05
B-547	26.02	34.22	.05
B-549	25.74	34.33	.05
B-550	26.04	34.27	.15
B-551	25.33	34.16	.20
B-552	25.71	34.14	.20
B-553	26.29	34.13	.05
B-554	25.90	34.16	.15
B-555	25.95	34.31	.10
B-556	26.28	34.45	.05
B-559	26.44	34.07	.05
B-560	26.37	34.04	.10
B-563	26.36	34.20	.05
B-564	26.65	34.07	0
B-567	25.59	34.33	.07
B-568	25.22	34.58	.20
B-569	26.44	34.38	.05
B-570	26.27	34.76	.05
B-574	25.79	34.51	.05
B-575	25.30	34.63	.20
B-576	26.31	34.18	.10
B-577	26.28	34.16	.15
B-581	26.25	34.51	.07
B-582	26.37		.05
B-655	28.92	34.42	0
B-657	28.62	34.31	.05
B-659	28.12	34.37	0
B-661	27.04	34.74	0
B-663	28.01	34.72	0
B-667	28.14	34.87	0
B-669	28.64	34.72	0
B-672	29.01	34.56	.10
B-675	29.21	34.38	0
B-677	28.23	34.52	0
B-680	29.08	34.29	.05
B-682	29.09	34.42	.05
B-684	30.28	34.23	0
B-686	30.19	34.02	0
B-689	30.40	34.09	0
B-691	29.21	34.04	0
B-695	28.81	34.67	0
B-696	29.76	34.23	.05
B-698	29.20	34.42	.05
B-700	29.23	34.36	.05
B-703	29.23	34.02	0
B-705	28.92	34.72	.05
B-708	29.07	34.04	0
B-710	29.16	34.42	0
B-712	29.03	34.78	0
B-716	29.69	34.54	.05
B-718	29.07	34.45	.05
B-721	28.73	34.26	.05
B-723	29.34	34.38	.05
B-725	28.72	34.40	.05
B-728	29.00	34.18	.05
B-730	29.13	34.07	0
B-732	29.01	34.34	.05
B-735	29.14	34.22	0
B-737	29.60	34.25	
B-739	29.02	34.23	.10
B-741	29.01	34.25	.05
B-744	29.83	34.23	0
B-748	28.85	34.31	0
B-751	29.09	34.11	0
B-753	29.34	34.00	.05
B-755	28.83	33.98	.15
B-758	29.49	34.07	.05
B-760	29.11	33.87	0
B-763	28.79	33.87	0
B-765	29.54	34.00	.15
B-767	29.80	34.05	.10
B-770	29.30	33.46	.05
B-772	29.17	33.98	.05
B-775	28.91	34.02	.05
B-777	28.94	33.98	.10
B-780	29.08	33.91	0
B-782	29.95	33.77	0
B-784	29.45	33.84	.05
B-786	29.24	33.96	.05
B-788	29.10	34.11	0
B-791	29.26	34.20	.05
B-794	29.23	34.13	.15

TABLE 5.—*Surface conditions, physical and chemical, at larval-fish and plankton tow stations*—Continued

Station No.	Temperature (°C.)	Salinity (o/oo)	Phosphate-P (ug-at/L)
B-796	29.55	34.16	0.05
B-798	29.86	33.93	0
B-801	29.50	34.16	.05
B-803	30.05	34.22	.15
B-805	29.73	34.22	.05
B-819	29.31	31.36	0
B-821	29.56	32.00	0
B-823	29.26	32.01	0
B-825	29.39	33.08	0
B-827	29.30	33.08	0
B-830	29.62	33.15	0
B-832	29.43	33.13	0
B-834	29.11	32.97	9
B-837	30.92	31.47	0
B-838	29.85	30.57	0
B-842	29.65	31.42	0
B-844	29.04	33.49	0
B-845	28.96	33.58	0
B-847	29.22	33.75	0
B-849	28.97	33.28	0
B-852	28.66	33.55	0
B-854	28.47	32.79	0
B-856	28.58	33.30	0
B-859	29.14	33.44	0
B-862	29.49	33.69	0
B-864	30.01	33.51	0
B-866	29.09	33.33	0
B-868	29.17	33.31	0
B-870	39.66	33.25	0
B-872	92.54	33.44	0
B-874	29.27	33.51	0
B-877	29.55	33.39	0
B-879	29.40	33.19	0
B-882	29.18	33.10	0
B-884	29.47	30.44	0
B-886	29.12	31.33	0
B-888	29.03	29.11	0
B-891	29.09	32.68	0
B-893	29.90	33.44	0
B-895	29.30	33.31	.10
B-898	29.30	33.46	0
B-900	28.99	33.31	0
B-902	28.72	33.40	0
B-904	28.99	33.37	0
B-907	28.75	33.40	0
B-909	28.73	33.40	.05
B-911	29.14	33.40	0
B-914	29.25	33.26	0
B-916	28.93	34.40	0
B-918	29.26	33.55	.05
B-921	29.10	34.20	0
B-923	29.81	32.84	0
B-925	29.74	33.33	0
B-928	29.81	33.04	0
B-930	30.13	33.17	0
B-937	28.19	34.00	0
B-939	28.10	33.93	.05
B-941	27.45	34.02	.05
B-943	28.34	34.02	.05
B-946	27.99	34.04	.05
B-948	28.52	33.95	.05
B-950	28.95	33.78	0
B-953	29.28	33.86	.05
B-955	28.98	33.28	0
B-958	29.30	33.68	.05
B-960	29.75	33.82	.05
B-962	29.52	33.73	.05
B-964	29.47	33.35	.10
B-967	29.43	32.70	0
B-969	29.26	33.35	.05
B-971	29.29	33.04	0
B-974	29.08	33.70	.05
B-976	29.65	33.64	0
B-980	29.33	33.78	0.05
B-982	29.46	33.64	.05
B-984	29.47	33.71	.05
B-987	29.18	33.60	0
B-989	29.19	33.62	.05
B-991	29.10	33.78	.05
B-993	28.95	33.94	.05
B-996	28.64	34.13	.05
B-998	29.26	33.63	0
B-1000	29.15	33.51	0
B-1003	29.28	33.45	0
B-1005	29.42	33.22	.05
B-1007	28.90	32.68	.05
B-1009	29.08	33.48	0
B-1012	29.30	32.58	0
B-1014	29.52	33.10	0
B-1016	29.22	32.83	0
B-1018	29.43	34.09	.05
B-1022	29.71	33.82	.05
B-1024	29.56	33.80	0
B-1028	29.71	33.86	0
B-1030	29.67	34.04	0
B-1031	29.36	34.18	0
B-1034	29.46	33.96	.05
B-1035	29.18	34.20	.03
B-1038	29.15	33.68	0
B-1040	29.06	33.44	.05
B-1042	29.20	33.93	0
B-2043	28.86	34.07	0
B-1045	29.28	33.42	.05
B-1046	29.24	33.01	.05
B-1048	28.93	34.04	.05
B-1050	29.86	33.68	0
B-1051	29.77	33.60	0
B-1053	29.37	33.46	.05
B-1057	29.41	34.14	.05
B-1060	29.31	34.07	.05
B-1071	29.43	34.09	.05
B-1072	29.17	34.09	.05
B-1075	29.44	33.93	.05
B-1076	28.91	33.98	.05
B-1077	28.92	33.98	.05
B-1079	28.74	33.98	.05
B-1080	28.92	34.09	.05
B-1081	28.82	34.02	.05
B-1083	29.04	34.22	.05
B-2084	29.92	34.27	.05
B-1085	28.85	33.98	.05
B-1087	29.11	33.93	.05
B-1088	29.33	33.66	.05
B-1089	29.03	33.87	.10
B-1091	29.12	33.98	.05
B-1092	29.67	34.00	.05
B-1093	29.06	33.89	.25
B-1095	28.99	33.98	.05
B-1102	28.92	32.77	.05
B-1105	27.49	34.43	.08
B-1106	28.59	33.98	.05
B-1108	27.52	33.95	.08
B-1110	28.53	33.95	.05
B-1111	28.26	33.66	0
B-1113	28.67	33.31	.05
B-1114	28.78	33.73	.05
B-1115	27.84	33.64	.05
B-1117	27.86	33.71	.05
B-1118	28.02	33.53	.05
B-1120	28.65	32.77	.05
B-1121	29.18	32.47	.05
B-1123	29.50	27.23	.05
B-1124	28.76	31.83	0
B-1125	28.33	33.21	.05
B-1127	28.43	32.92	.05
B-1129	28.03	32.27	.25

A number of probable tuna-spawning areas have been determined tentatively by the collection of larval forms. The larger areas (fig. 1), bounded by broken lines, indicate the presence of tuna-like larvae either in consecutive or closely related tows. The small, diamond-shaped areas are those in which a


PHILIPPINE ISLANDS
TUNA SPAWNING AREAS
TAIWAN
LUZON
MINDORO
PANAY
NEGROS
SAMAR
PALAWAN
MINDANAO
BORNEO
CELEBES
HALMAHERA
115°
120°
125°
130°
20°
15°
10°
5°
0°
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single, isolated haul contained sufficient larvae to seem significant. Each area is identified by a number, and the complete data regarding it are given in table 6. Not included on this chart are those isolated tows in which only very few larvae were taken.

The larvae of some species of tuna-like fishes can be taken throughout the year in Philippine waters, although certain areas seem to be favored. The principal spawning area, as indicated by the collections of the Philippine Fishery Program, is in the northern Sulu Sea and off the west coast of Mindoro Island. Other areas in which considerable numbers of larvae were found are the South China Sea off the west coast of Palawan Island, the southern Sulu Sea, and the south coast of Mindanao Island. Other spawning areas are smaller and more widely scattered, but it should be pointed out that if equal emphasis had been placed upon collecting throughout the archipelago, the distribution would have probably been more uniform.

TABLE 6.—*Principal concentrations of larval tuna and tuna-like fishes found in Philippine waters, 1947–49*

Area and station	Date	Latitude	Longitude	Larvae taken, by genus
Area 1	October 1947			5 *Neothunnus*, 13 *Katsuwonus*, 5 *Euthynnus*.
B-34	Oct. 13	10°02′ N.	120°21.8′ E.	
B 35	Oct. 13	9°44′ N.	120°38′ E.	
B-36	Oct. 14	9°08′ N.	121°12.5′ E.	
B 37	Oct. 14	8°32′ N.	121°48.5′ E.	
Area 2	December 1947			16 *Neothunnus*, 3 *Katsuwonus*.
B 50	Dec. 4	7°16′ N.	120°45′ E.	
B 51	Dec. 5	6°57.5′ N.	121°02.5′ E.	
Area 3	December 1947			60 *Neothunnus*, 37 *Katsuwonus*, 46 *Euthynnus*, 7 undetermined.
B 55	Dec. 6	7°08′ N.	119°27′ E.	
B 56	Dec. 6	7°54′ N.	118°51′ E.	
B-57	Dec. 6	8°32′ N.	118°20′ E.	
B-58	Dec. 7	8°00.5′ N.	117°40′ E.	
B 62	Dec. 9	7°27′ N.	118°15′ E.	
B 64	Dec. 10	6°48.5′ N.	118°51.5′ E.	
B 65	Dec. 11	5°57.5′ N.	119°09′ E.	
B-66	Dec. 11	5°57′ N.	119°39.5′ E.	
Area 4	March 1948			3 *Katsuwonus*, 6 *Auxis*, 9 *Euthynnus*.
B-123	Mar. 2	2° N.	126° E.	
B 124	Mar. 3	3° N.	126° E.	
Area 5	April 1948			11 *Katsuwonus*, 8 *Euthynnus*, 1 *Auxis*.
B 154	Apr. 10	1°29′ N.	121° E.	
B 156	Apr. 10	2° N.	121° E.	
B 157	Apr. 11	3° N.	120°55′ E.	
B 160	Apr. 12	3° N.	120° E.	
Area 6	April 1948			1 *Katsuwonus*, 1 *Auxis*, 9 *Euthynnus*.
B 177	Apr. 16	5° N.	120°30′ E.	
B 178	Apr. 17	5°05′ N.	121°04.5′ E.	
Area 7	April 1948			2 *Katsuwonus*, 2 *Auxis*.
B-186	Apr. 19	6°41′ N.	122°23′ E.	
B 187	Apr. 20	7° N.	123° E.	
B-188	Apr. 20	6°57′ N.	122°25′ E.	
Area 8	June 1948			1 *Neothunnus*, 1 undetermined.
B 244	June 16	10°45′ N.	121°48′ E.	
B 246	June 16	10°32.5′ N.	121°02′ E.	
Area 9	July 1948			1 *Katsuwonus*, 2 undetermined.
B 294	July 10	6°26.5′ N.	120°24′ E.	
B 295	July 11	5°57′ N.	119°56′ E.	
B-296	July 11	5°53′ N.	119°23′ E.	
Area 10	July 1948			1 *Neothunnus*, 6 *Katsuwonus*, 1 undetermined.
B 329	July 30	5° N.	120°30′ E.	
B 330	July 30	4°45′ N.	119°53′ E.	
B-331	July 31	4°31′ N.	119°30′ E.	
Area 11	August 1948			18 *Euthynnus*, 2 *Auxis*, 1 *Neothunnus*, 1 *Katsuwonus*, 1 undetermined.
B 338	Aug. 1	1°56.5′ N.	119° E.	
B 339	Aug. 1	1° N.	119°08′ E.	
Area 12	August 1948			16 *Euthynnus*, 7 undetermined.
B 353	Aug. 5	3° N.	122° E.	
B 355	Aug. 6	4° N.	122° E.	
B 356	Aug. 6	5° N.	122° E.	
Area 13	September 1948			3 *Neothunnus*, 11 *Euthynnus*, 2 *Katsuwonus*, 10 undetermined.
B 375	Sept. 4	7° N.	123°49′ E.	
B 376	Sept. 5	6° N.	124° E.	
B 378	Sept. 5	5° N.	124° E.	
B 379	Sept. 5	4° N.	125° E.	
B 380	Sept. 6	5°18′ N.	125°30′ E.	
B 383	Sept. 6	5° N.	126° E.	
B 384	Sept. 7	6° N.	125°48′ E.	
B 387	Sept. 7	6°22′ N.	125°53′ E.	
B 388	Sept. 7	6°44′ N.	125°46′ E.	
Area 14	September 1948			2 *Katsuwonus*, 2 *Euthynnus*, 5 undetermined.
B 405	Sept. 13	1°08′ N.	124° E.	
B 407	Sept. 13	1°13′ N.	123° E.	
B 408	Sept. 14	2° N.	123° E.	
B 411	Sept. 14	2°56′ N.	123°03.5′ E.	

FIGURE 1.—Spawning areas of tuna and tuna-like fishes in Philippine waters. Broken lines indicate areas in which larvae were taken in two or more consecutive or closely related tows. Diamond-shaped signs indicate isolated, single catches in which a quantity of tuna-like larvae were found.

TABLE 6.—*Principal concentrations of larval tuna and tuna-like fishes found in Philippine waters, 1947–49*—Continued

Area and station	Date	Latitude	Longitude	Larvae taken, by genus
Area 15	January 1949			1 *Neothunnus*, 1 undetermined.
B-479	Jan. 14	14°20′ N.	119°10′ E.	
B-482	Jan. 14	14°30′ N.	119°50′ E.	
Area 16	January 1949			123 *Euthynnus*, 106 *Auxis*, 2 *Katsuwonus*, 7 undetermined.
B-484	Jan. 21	13°35′ N.	120°07′ E.	
B-485	Jan. 22	13°24′ N.	119°39′ E.	
B-486	Jan. 22	12°42.5′ N.	119°32.5′ E.	
B-487	Jan. 22	12°59′ N.	119°56′ E.	
B-488	Jan. 22	13°16′ N.	120°21′ E.	
B-490	Jan. 23	12°50′ N.	120°37′ E.	
B-492	Jan. 23	12°32.5′ N.	120°08.5′ E.	
B-494	Jan. 24	12°24′ N.	120°52.5′ E.	
B-495	Jan. 24	12°07′ N.	121°04.5′ E.	
B-497	Jan. 24	11°31′ N.	120°39′ E.	
B-498	Jan. 24	11°45.3′ N.	121°11.2′ E.	
B-499	Jan. 24	11°43′ N.	121°48′ E.	
B-500	Jan. 25	10°52.5′ N.	121°51.5′ E.	
B-501	Jan. 25	10°56′ N.	120°52.5′ E.	
B-502	Jan. 25	10°36′ N.	120°37′ E.	
B-503	Jan. 25	10°19′ N.	120°03′ E.	
Area 17	February 1949			6 undetermined.
B-523	Feb. 2	10°17′ N.	118°06′ E.	
B-527	Feb. 3	11°03′ N.	119°03′ E.	
Area 18	February 1949			31 *Euthynnus*, 9 *Katsuwonus*, 1 *Neothunnus*, 11 undetermined.
B-532	Feb. 14	13°47′ N.	120°35′ E.	
B-533	Feb. 14	13°35′ N.	120°32′ E.	
B-534	Feb. 14	13°37′ N.	120°47′ E.	
B-535	Feb. 15	13°22′ N.	121°27′ E.	
B-536	Feb. 15	13°35′ N.	121°25′ E.	
Area 19	February 1949			334 *Euthynnus*, 4 undetermined.
B-540	Feb. 15	12°37.5′ N.	121°32.5′ E.	
B-543	Feb. 16	12°17′ N.	121°30′ E.	
B-544	Feb. 16	12°06′ N.	121°40′ E.	
B-545	Feb. 16	11°55′ N.	121°50′ E.	
Area 20	February 1949			17 *Euthynnus*, 1 *Auxis*, 12 undetermined.
B-551	Feb. 17	11°04′ N.	123°48′ E.	
B-552	Feb. 17	10°39′ N.	123°42′ E.	
B-553	Feb. 17	10°40′ N.	123°32.5′ E.	
B-554	Feb. 18	9°46′ N.	123°14.8′ E.	
Area 21	February 1949			7 undetermined.
B-559	Feb. 19	10°23′ N.	124°09′ E.	
B-560	Feb. 19	10°40′ N.	124°38′ E.	
Area 22	May 1949			2 *Neothunnus*, 1 *Katsuwonus*, 4 *Euthynnus*, 4 undetermined.
B-691	May 24	14°30′ N.	122°04′ E.	
B-695	May 24	14°52′ N.	122°28.9′ E.	
B-696	May 24	15°35′ N.	124°40′ E.	
Area 23	May 1949			1 *Neothunnus*, 2 undetermined.
B-718	May 27	15°12′ N.	127°36′ E.	
B-721	May 28	14°21′ N.	128°15′ E.	
Area 24	July 1949			4 *Neothunnus*, 4 *Auxis*, 3 undetermined.
B-823	July 18	8°07.5′ N.	116°07′ E.	
B-825	July 19	9°20′ N.	117°03.5′ E.	
B-827	July 19	9°12′ N.	117°15.9′ E.	
B-830	July 19	10°17′ N.	118°06′ E.	
Area 25	August 1949			5 *Neothunnus*, 8 undetermined.
B-864	Aug. 1	13°45′ N.	117°53′ E.	
B-866	Aug. 1	13°34′ N.	117°07′ E.	
B-868	Aug. 3	14°22′ N.	117°08′ E.	
Area 26	August 1949			11 *Neothunnus*.
B-893	Aug. 6	17°37′ N.	119°26′ E.	
B-895	Aug. 6	17°52′ N.	118°37′ E.	
Area 27	August 1949			2 *Neothunnus*.
B-909	Aug. 8	20°25′ N.	119°16′ E.	
B-911	Aug. 9	20°42′ N.	120°04′ E.	
Area 28	August 1949			2 *Neothunnus*.
B-974	Aug. 30	9°13′ N.	121° E.	
B-976	Aug. 30	9°09′ N.	120°04′ E.	
Area 29	September 1949			7 *Neothunnus*, 8 *Katsuwonus*, 3 *Euthynnus*, 4 undetermined.
B-991	Sept. 4	8°15′ N.	122°29′ E.	
B-993	Sept. 4	8°37′ N.	123°04′ E.	
B-996	Sept. 4	9° N.	123°03′ E.	
B-998	Sept. 4	8°53′ N.	121°47′ E.	
B-1000	Sept. 5	9°31′ N.	122°15′ E.	
B-1003	Sept. 5	10°27′ N.	121°51′ E.	
B-1005	Sept. 5	10°21′ N.	121°11′ E.	
B-1007	Sept. 5	11°44′ N.	121°48′ E.	
Area 30	September 1949			8 *Neothunnus*, 1 undetermined.
B-1040	Sept. 18	10°44′ N.	125°19′ E.	
B-1042	Sept. 19	9° N.	124°39′ E.	
Area 31	October 1949			1 *Neothunnus*, 4 undetermined.
B-1080	Oct. 18	10°55′ N.	128°27′ E.	
B-1081	Oct. 19	11°07′ N.	129°27′ E.	
B-1083	Oct. 19	12°14′ N.	130°12′ E.	
Area 32	November 1949			3 *Neothunnus*, 7 *Euthynnus*, 4 undetermined.
B-1108	Nov. 18	12°10′ N.	124°06′ E.	
B-1110	Nov. 18	11°38′ N.	128°38.5′ E.	
B-1111	Nov. 19	11°23.5′ N.	123°20.7′ E.	
B-1113	Nov. 19	11°39′ N.	123°02′ E.	
B-1114	Nov. 19	11°56′ N.	123°19′ E.	
Area 33	November 1949			3 *Neothunnus*, 3 *Auxis*, 7 *Euthynnus*.
B-1117	Nov. 20	11°33′ N.	120°51′ E.	
B-1118	Nov. 21	10°45′ N.	120°40′ E.	

TABLE 6.—*Principal concentrations of larval tuna and tuna-like fishes found in Philippine waters, 1947–49*—Continued

Area and station	Date	Latitude	Longitude	Larvae taken, by genus
Area 34	February 1948			15 *Euthynnus.*
B-101	Feb. 23	7° N.	123°49′ E.	
Area 35	March 1948			6 *Neothunnus*, 1 *Euthynnus.*
B-133	Mar. 7	1°06.3′ N.	123°59′ E.	
Area 36	April 1948			2 *Neothunnus*, 2 *Katsuwonus.*
B-171	Apr. 15	4°08.5′ N.	120°06′ E.	
Area 37	July 1948			7 *Euthynnus.*
B-309	July 14	7°26.5′ N.	116°55′ E.	
Area 38	August 1948			15 undetermined.
B-348	Aug. 4	2° N.	121° E.	
Area 39	September 1948			8 *Euthynnus*, 1 *Katsuwonus.*
B-415	Sept. 15	6° N.	123° E.	
Area 40	January 1949			17 *Euthynnus.*
B-510	Jan. 28	6°56′ N.	118°14′ E.	
Area 41	February 1949			298 *Euthynnus*, 5 *Katsuwonus*, 3 *Auxis*, 1 *Neothunnus.*
B-529	Feb. 3	11°44′ N.	118° E.	
Area 42	May 1949			12 *Neothunnus*, 2 *Katsuwonus.*
B-675	May 20	17°28′ N.	123°45′ E.	
Area 43	August 1949			5 *Euthynnus.*
B-888	Aug. 6	16°21′ N.	120°12′ E.	
Area 44	August 1949			4 *Neothunnus.*
B-930	Aug. 11	17°56′ N.	120°11′ E.	
Area 45	September 1949			14 *Neothunnus*, 3 *Katsuwonus.*
B-1028	Sept. 14	12°55′ N.	122°30′ E.	

DESCRIPTION OF SPECIES

There are 21 species of tuna and tuna-like fishes found in the Philippine Islands according to Herre (1950). These can be united into 15 genera and either 2, 3, or 4 families, according to the taxonomic authority one accepts. Herre, as well as Jordan (1923), places the so-called scombroid fishes in two families, Scombridae and Thunnidae. The classification used by Berg (1940) created an additional family, Cybiidae, and Kishinouye (1917) placed a portion of the thunnid fishes in a new family, Katsuwonidae. The nomenclature of Kishinouye (1923) has been retained in this publication, in general.

Ten of the 21 species found in Philippine waters are known to occur in some abundance throughout most of the archipelago. The remainder are either quite rare or occur only occasionally. In the family Scombridae, two species of deep-bodied mackerels, genus *Rastrelliger*, are abundant. The family Cybiidae is represented abundantly by *Scomberomorus commerson* and *Gymnosarda nuda*, although occasionally *Sarda orientalis* is taken in considerable quantities. Two species of the family Thunnidae are known to be common, *Neothunnus macropterus* and *Kishinouella tonggol*. There is an abundance of *Katsuwonus pelamis*, *Euthynnus yaito*, *Auxis thazard*, and *Auxis tapeinosoma*, all of the family Katsuwonidae.

An additional species of the family Thunnidae, *Thunnus orientalis*, may occur in some degree of abundance in Philippine waters, but is not found in the commercial catch at the present time. Prior to World War II the Japanese carried on a fishery for this species between northern Luzon and Taiwan (Formosa), but nothing is known of the magnitude of the catch nor the actual extent of the fishing grounds.

The collections made by the Philippine Fishery Program contain the larvae of 5 species of tuna-like fish which can be identified with some degree of accuracy: *Grammatorcynus bicarinatus*, *Neothunnus macropterus*, *Katsuwonus pelamis*, *Euthynnus yaito*, and *Auxis* sp.(?). It has been impossible to separate the two species of the genus *Auxis* known to inhabit Philippine waters, and the description of specimens of this genus may include both species. The larvae of the remaining 16 species of tuna-like fishes are not known at present. Until the larvae of all the so-called scombroid fishes are known, the specific identification of the larval stages of this group will present difficult and complex problems.

The preparation of an adequate description of the several species of larval tunas is a difficult task. The many changes that accompany the rapid growth of the larval forms make illogical any attempt to describe the species using the standard ichthyological technique of proportional measurements and counts. Rather, a general description of each of several sizes of each species, accompanied by adequate illustrations, will be of greater value to future investigations. Several specimens of each species were cleared and stained, using the technique employed by Hollister (1934).

The most complete previous study of tuna and tuna-like larvae was that of Ehrenbaum (1924) who studied collections from the Mediterranean Sea and several portions of the Atlantic Ocean. By his own admission, he could not identify positively every specimen in his possession, and consequently, his results, like the present paper, probably contain some errors. Ehrenbaum explained his lack of positive results as due to the absence of larger larval forms in the collections he studied (which were not obtained during the most favorable season for capturing larvae) and to insufficient knowledge of the morphology and anatomy of the tunas and related species. Although his work has been cited as a general reference, Ehrenbaum's specific identifications have not been used for the most part.

Almost nothing is known concerning the larval forms of tuna and tuna-like fishes found in the Pacific area. The earliest record was made by Lütken (1880) who identified a 17 mm. and a 10 mm. specimen as *Orcynnus* (= *Thunnus*) *germo*. Although no locality record is available for the larger specimen, it probably came from the East Indies, as the vessel from which it was captured was working in that area during the period it was taken, June 3, 1836. The smaller specimen was taken from the South China Sea at an unknown date. It has been suggested by Schaefer and Marr (1948) that these specimens may be the young of *Neothunnus macropterus*. In 1889, Günther, while studying the fish of the *Challenger* expedition, recorded as *Euthynnus yaito* a 0.72-inch thunnid-like specimen taken south of the Caroline Islands in the western Pacific.

The Japanese knowledge of the larval and juvenile forms has been summarized by Kishinouye (1919, 1926). Only a few larval specimens were available in his collections, and his work deals mainly with juveniles. Recently, Schaefer and Marr (1948a, 1948b), Schaefer (1948), Marr (1948), and Wade (1949, 1950) have studied the juvenile stages of this group in the eastern, central, and western Pacific areas. With the exception of Lütken and Kishinouye, no larval specimens have been recorded from the Pacific Ocean until the Philippine Fishery Program of the Fish and Wildlife Service accumulated the collection described herein.

GRAMMATORCYNUS BICARINATUS (Quoy and Gaimard)

Family CYBIIDAE

Genus *Grammatorcynus* Gill

Grammatorcynus Gill, 1862, Proc. Acad. Nat. Sci. Philadelphia vol. 14, p. 125, orthotype *Thunnus bilineatus* Rüppell.

Grammatorcynus bicarinatus (Quoy and Gaimard)

The species is not common in waters of the Philippines, but it was seen occasionally in small numbers in the public fish markets of Zamboanga, Mindanao, and Jolo, Sulu Archipelago. While it is neither a commercially important nor an abundant species, its identification is another step in the process of distinguishing the larval forms of the tuna and tuna-like fishes inhabiting these waters. The larger of the two specimens illustrated (fig. 3) is not a larval form, but has been included because of its usefulness in identifying the young of this species.

Five of the 8 specimens collected were captured under a night light aboard the experimental fishing vessel *Theodore N. Gill*. Three specimens were taken by the research vessel, *Spencer F. Baird*, 1 under a night light, and 2 in plankton tows.

TABLE 7.—*Station list of* Grammatorcynus bicarinatus *collected in Philippine waters, 1947–49*

Station	Date	Latitude	Longitude	Specimens	
				Number	Size (mm
B–29	12 Oct. 1947	6°57′ N.	120°15′ E.	1	
B–339	1 Aug. 1948	1° N.	119°08′ E.	1	1
B–345	3 Aug. 1948	4°05′ N.	120°59′ E.	1	
G–65 [1]	3 May 1948	6°04.25′ N.	120°45.5′ E.	4	10–1
G–68	6 May 1948	6°43.6′ N.	119°12′ E.	1	1

[1] The prefix G refers to stations made by the *Theodore N. Gill*, experimental fishing vessel, Philippine Fishery Program, Fish and Wildlife Service.

The smallest specimen in the collections is 8.5 mm. fork length [2] (fig. 2). The body is deep and heavy. The dorsal outline is almost horizontal from nape to the posterior third of length, then tapers to the slender caudal peduncle. The ventral outline is more or less evenly rounded, anterior to the anal opening. Posterior to the anal opening, the ventral

[2] Fork length is the length from the tip of the snout to the end of the middle caudal rays and is used after the caudal fin becomes forked.

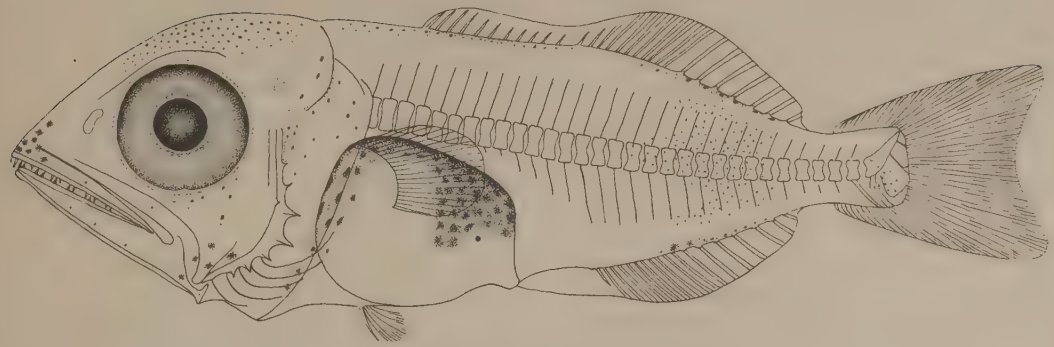

FIGURE 2.—*Grammatorcynus bicarinatus*, 8.5 mm.

FIGURE 3.—*Grammatorcynus bicarinatus*, 17.5 mm.

outline gradually tapers to the caudal region. The abdominal sac is large, somewhat longer than deep, and the anal opening is about midlength of the body.

The head is large, but not disproportionately so, and its dorsal outline is evenly rounded from above the eye to the tip of the snout. The length of the short, bluntly rounded snout is equal to approximately three-quarters of the eye diameter. The mouth is moderately oblique, and the end of the maxillary extends posteriorly to an imaginary vertical line drawn through the center of the pupil of the eye. The eye is large, almost one-half of the head length. There are eight or nine teeth on each side of both jaws, and the lower jaw is slightly included at the tip.

The development of spines around the edge of the preoperculum is in contrast to the development characteristics of thunnid and katsuwonid larvae which have several long, slender spines at or near the angle of the preoperculum. *Grammatorcynus* spines are all short, heavy, and bluntly pointed. The spine at the angle of the preoperculum is the largest, with three smaller spines along the vertical edge which become progressively smaller dorsally. Three small spines almost equal in size are located along the horizontal edge of the preoperculum. A small spine lies on a faintly marked crest on the surface of the preoperculum. The vertebrae are developed and easily counted in a cleared and stained specimen. There are 13 abdominal vertebrae and 18 caudal vertebrae, a total of 31.

Moderately developed pectoral and small ventral fins are present. The ventral fins are inserted close to the ventral midline beneath the pectoral base. The caudal fin is well developed and slightly forked. The median fins are all present. The first dorsal fin is low, its 13 spines short and weakly developed. The last spine of the first dorsal is almost united with the first ray of the second dorsal. The well-developed second dorsal has 9 rays and 7 finlets, while the anal fin has 11 rays and 7 finlets.

Preserved specimens are light cream in color, with a scattered pattern of small black pigment spots. The dorsal aspect of the head from the nape anteriorly to above the eye is lightly pigmented with small black chromatophores; while laterally, below the nape and behind the eye, there are several scattered areas of similar pigment. There is scattered dark pigmentation on the tip of the snout and immediately posterior to the angle of the jaws. The bases of first dorsal and of both dorsal and anal finlets have a narrow line of dark pigment. A lightly pigmented area extends over the side of the body between the dorsal and anal finlets. There are a few scattered pigment spots at the base of the caudal fin. The abdominal sac is darkly and heavily pigmented dorsally and anteriorly, and the color pattern also extends downward laterally on the posterior portion of the sac.

All other specimens in the collection are larger than 8.5 mm., but show much the same, although more completely developed, characters. The largest specimen, 17.5 mm. fork length, is illustrated in figure 3 principally to show the characteristic color pattern. This color pattern is already faintly evident in the 8.5 mm. specimen, and by the time this species is 10 mm. in length, it is strongly marked.

In the 17.5 mm. specimen, the preopercular spines have developed into a serrated row of 10 short, blunt projections, 6 along the horizontal edge, 1 at the angle, and 3 on the vertical edge. The first dorsal is well developed and the second spine is the longest. Figure 3 is slightly in error with regard to both dorsal and anal finlets for what appears to be the last ray is actually the first finlet. In the specimen it lies close to the last ray, but not as close as the illustration seems to indicate. The second dorsal count is 10 rays plus 7 finlets, and the anal count is 12 rays plus 7 finlets.

G. bicarinatus can be easily separated from the other forms described in this paper by the distinctive color pattern in the larger sizes. Always it can be distinguished by the fewer vertebrae, 31, instead of 39 or 41 as in the other species. The vertebral count is the same as Kishinouye (1923) gave for the deep-bodied mackerel, *Rastrelliger*, but *Grammatorcynus bicarinatus* has 7 dorsal and anal finlets instead of 5, as in *Rastrelliger*.

All of the specimens were taken from the southeastern Sulu Sea and the western portion of the Celebes Sea during the months of May, August and October.

NEOTHUNNUS MACROPTERUS (Temminck and Schlegel)

Family THUNNIDAE

Genus *Neothunnus* Kishinouye

Neothunnus Kishinouye, 1923, Contributions to the comparativ study of the so-called scombroid fishes. Jour. College of Agr culture, Imperial Univ. Tokyo, vol. 8, p. 445, type *Neothunn macropterus* (Temminck and Schlegel).

Neothunnus macropterus (Temminck and Schlegel)

The smallest recognizable specimen of *Neothunnu macropterus* (fig. 4) in the collections studied is 5.1

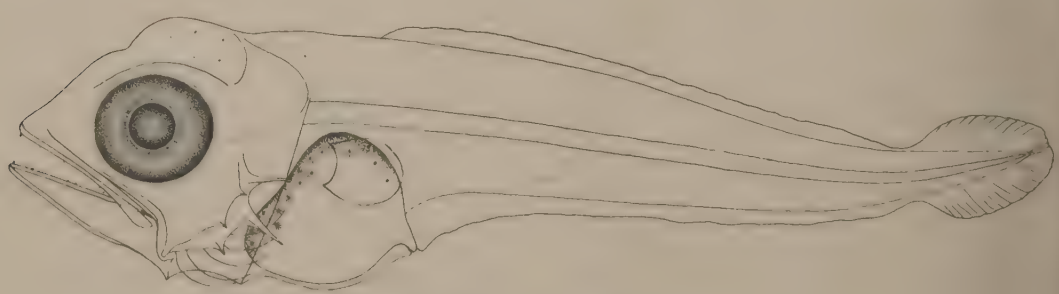

FIGURE 4.—*Neothunnus macropterus*, 5.15 mm.

mm. in total length.[3] This specimen is comparatively long and slender, with its greatest depth immediately behind the eye. The dorsal outline tapers gradually from the greatest depth to the end of the urostyle. The ventral outline is deep and unevenly rounded from the tip of the snout to the anal opening, and then it tapers evenly to the end of the tail.

TABLE 8.—*Station list of larval* Neothunnus macropterus *collected in Philippine waters, 1947–49*

Station	Date	Latitude	Longitude	Specimens	
				Number	Size (mm.)
B-16	7 Oct. 1947	11°07.5′ N.	121°56′ E.	2	6–6.1
B-17	do	10°13′ N.	121°20′ E.	1	5.0
B-34	13 Oct. 1947	10°02′ N.	121°21.8′ E.	5	4.8–5.1
B-50	4 Dec. 1947	7°16′ N.	120°45′ E.	16	6.1 7.8
B 55	6 Dec. 1947	7°08′ N.	119°27′ E.	1	5.2
B-56	do	7°54′ N.	118°51′ E.	10	4.4–6.0
B-57	do	8°32′ N.	118°20′ E.	15	4.8–8.1
B-62	9 Dec. 1947	7°27′ N.	118°15′ E.	6	5–7.5
B-66	11 Dec 1947	5°57′ N.	119°39.5′ E.	28	4–6.8
B-120	1 Mar. 1948	3° N.	125° E.	1	5.4
B-133	7 Mar. 1948	1°06.3′ N.	123°59′ E.	6	5.5–5.8
B-160	12 Apr. 1948	3° N.	120° E.	1	8.3
B-171	15 Apr. 1948	4°08′ N.	120°06′ E.	2	8.4–8.7
B-186	19 Apr. 1948	6°41′ N.	122°23′ E.	3	5.6–6.5
B 246	16 June 1948	10°32.5′ N.	121°02′ E.	1	7.8
B-250	17 June 1948	8°56′ N.	123° E.	3	4–4.5
B 253	do	8°43′ N.	122°40′ E.	2	5.5–7.1
B-263	20 June 1948	8°51′ N.	121°03′ E.	2	8.0
B-331	31 July 1948	4°31′ N.	119°30′ E.	1	7.3
B-338	1 Aug. 1948	1°56.5′ N.	119° E.	1	9.0
B-379	5 Sept. 1948	5° N.	125° E.	1	8.8
B-380	6 Sept. 1948	5°18′ N.	125°30′ E.	1	5.6
B 387	7 Sept. 1948	6°22′ N.	125°53′ E.	1	5.0
B-400	12 Sept. 1948	4° N.	125° E.	1	8.3
B 479	14 Jan. 1949	14°20′ N.	119°10′ E.	1	6.0
B-500	25 Jan. 1949	10°52.5′ N.	121°51.5′ E.	1	5.9
B-529	3 Feb. 1949	11°44′ N.	118° E.	1	7.0
B 536	15 Feb. 1949	13°35′ N.	121°25′ E.	1	(1)
B 675	16 May 1949	17°28′ N.	123°45′ E.	12	5.1–8.5
B-680	21 May 1949	17°06.5′ N.	122°36.7′ E.	2	5.5–6.9
B 696	24 May 1949	15°35′ N.	124°40′ E.	2	6.5–7.4
B-703	25 May 1949	14°49′ N.	124°07′ E.	1	5.0
B 721	28 May 1949	14°21′ N.	128°15′ E.	1	5.2
B-732	30 May 1949	11°50′ N.	126°43′ E.	2	5.5–7.4
B 796	11 June 1949	8°44′ N.	127°20′ E.	1	7.0
B 827	19 July 1949	9°12′ N.	117°15.9′ E.	3	5–5.3
B-830	do	10°17′ N.	118°06′ E.	1	5.6
B-832	do	10°25′ N.	117°46′ E.	13	5.2–9.9
B 847	24 July 1949	12°55′ N.	117°04′ E.	1	6.0
B-866	1 Aug. 1949	13°34′ N.	117°07′ E.	1	6.2
B-868	3 Aug. 1949	14°22′ N.	117°08′ E.	4	5.1–5.5
B-882	5 Aug. 1949	15°05′ N.	119°50′ E.	2	5–5.9
B 893	6 Aug. 1949	17°37′ N.	119°26′ E.	10	4.9–6.2
B-895	do	17°52′ N.	118°37′ E.	1	(1)
B 900	7 Aug. 1949	18°08′ N.	117°32′ E.	2	(1)
B-909	8 Aug. 1949	20°25′ N.	119°16′ E.	1	5.9
B-911	9 Aug. 1949	20°42′ N.	120°04′ E.	1	5.5
B 916	do	21°03′ N.	120°52′ E.	1	11.9
B-921	10 Aug. 1949	19°32′ N.	120°52′ E.	1	9.0
B-925	11 Aug. 1949	18°58′ N.	119°47′ E.	1	5.2
B-930	do	17°56′ N.	120°11′ E.	4	4.9–5.3
B-974	30 Aug. 1949	9°13′ N.	121° E.	1	7.8
B-976	do	9°09′ N.	120°04′ E.	1	4.6
B-993	4 Sept. 1949	8°37′ N.	123°04′ E.	1	7.3
B-1005	5 Sept. 1949	10°21′ N.	121°11′ E.	6	4.8–5.1
B-1022	13 Sept. 1949	12°30′ N.	121°45′ E.	3	4.9–5.2
B-1028	14 Sept. 1949	12°55′ N.	122°30′ E.	14	4.7–8.9
B-1034	15 Sept. 1949	13°07′ N.	124°18′ E.	1	(1)
B-1040	18 Sept. 1949	10°44′ N.	125°19′ E.	8	4.9–6.9
B-1051	22 Sept. 1949	10°52′ N.	124°12′ E.	1	5.0
B-1081	18 Oct. 1949	11°07′ N.	129°27′ E.	1	5.2
B-1092	21 Oct. 1949	8°44′ N.	127°38′ E.	1	6.1
B-1108	18 Nov. 1949	12°10′ N.	124°06′ E.	3	4.7–6.8
B-1118	21 Nov. 1949	10°45′ N.	120°40′ E.	3	5.6–5.9

[1] Distorted.

[3] Total length is the length of the specimen from the tip of the snout to the end of the caudal fin and is used as a measurement of length before the caudal fin becomes forked.

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The abdominal sac is small, anteriorly placed, and slightly longer than high. The anal opening is well forward of the midpoint of the longitudinal axis of the body.

The head is of moderate size, not disproportionately large as in later stages. The snout is short and bluntly pointed, slightly more than half the eye diameter in length. The dorsal outline of the snout is much steeper than the ventral outline. The tip of the snout is even with a horizontal line drawn through the lower edge of the pupil of the eye. The mouth is moderately oblique and large. The end of the maxillary reaches almost to or slightly posterior to a vertical line drawn through the posterior edge of the pupil of the eye. There are 3 to 5 teeth on each side of both jaws. The lower jaw is slightly included at the tip. The nostrils are not evident in specimens of this size.

Three large spines have developed along the edge of the preoperculum. The middle spine, located at the angle, is long, slender, and extends downward and backward over the abdominal sac. The dorsally placed spine is only slightly smaller than the center spine, while the lower spine is much shorter and rather blunt. There are two small blunt spines lying along a slight crest on the preopercular surface. The vertebrae cannot be distinguished, and the urostyle is elongate and bent slightly upward.

The pectoral fins are present, although small and difficult to locate, while the ventral fins remain undeveloped. No median fins are present, but are represented by a low, continuous membrane beginning on the dorsal midline, just behind the base of the pectoral, and extending backward around the caudal tip and forward along the ventral midline to the anal opening. No fin rays are present in the median membrane, although faint streaks are visible in the caudal region.

The color of formalin-preserved specimens is white. A few small black chromatophores are scattered throughout the membrane covering the brain. The peritoneal lining of the abdominal sac is darkly pigmented dorsally and anteriorly.

In somewhat larger specimens, 6.19 to 6.7 mm. (figs. 5 and 6) the body is heavier anteriorly; otherwise, the body shape is much the same as in the smaller specimens. The head is larger and more pronounced in relation to the rest of the body, and the eye has grown relatively smaller as the head has increased in size. The snout is longer, more pointed,

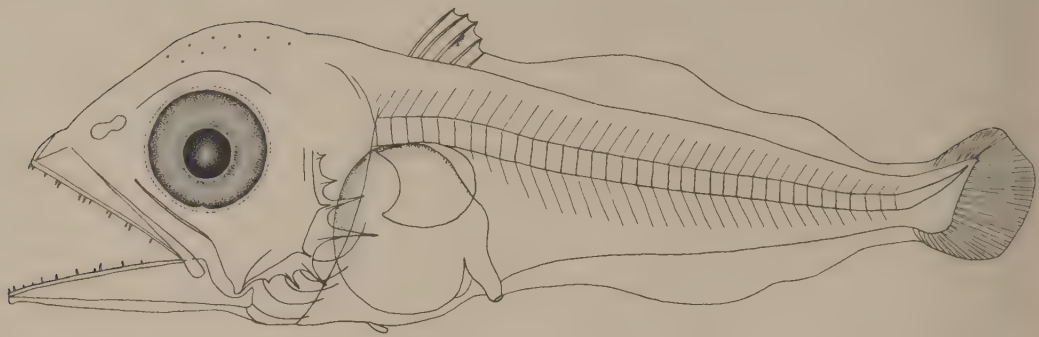


FIGURE 5.—*Neothunnus macropterus*, 6.19 mm.

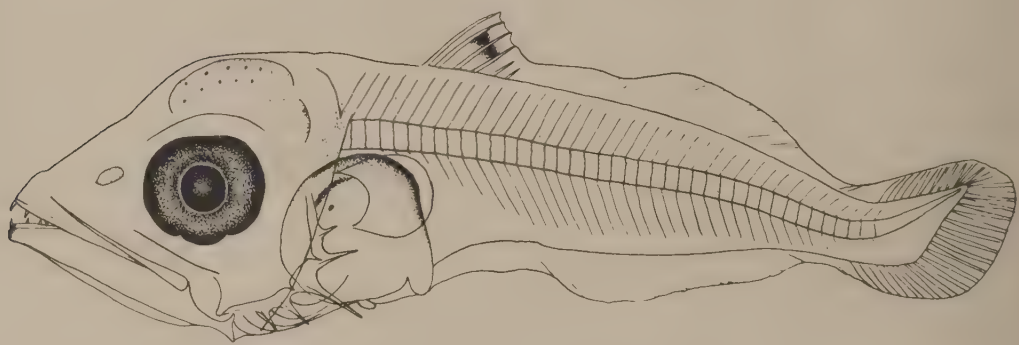


FIGURE 6.—*Neothunnus macropterus*, 6.7 mm.

and is equal to, or slightly greater than, the eye diameter The mouth remains large, and the number of teeth on each side of both jaws has increased to between five and seven. No vomerine or palatine teeth are evident. The mouth is moderately oblique, and the end of the maxillary reaches to a vertical between the center and posterior edge of the eye. The lower jaw is slightly included at the tip.

Five to seven spines have developed along the edge of the preoperculum. Of the three large spines at the angle, the center spine is the longest and most slender. One or two short blunt spines occur on both the vertical and horizontal edges. Two short blunt spines are present on a slight crest of the surface of the preoperculum. The vertebrae are scarcely evident and can be seen faintly in cleared and stained specimens. Approximately 36 vertibrae can be distinguished in the 6.19 mm. specimen, whereas about 38 are evident in the 6.7 mm. example.

Five or six rays have developed in the first dorsal fin, but no rays are yet evident in the second dorsal, anal, pectoral, or ventral fins. The ventral fins can be detected only as small "buds" lying below the base of the pectoral fins. Faint vertical streaks are present in the membrane in the region of the second dorsal and anal fins. The caudal rays are clearly evident.

These specimens retain the white coloration characteristic of the smaller examples. A slight scattered black pigmentation is found on the membrane covering the brain as well as on the anterior and dorsal surfaces of the peritoneum of the abdominal sac. In both of these specimens a small dark area of pigment occupies the center of the first dorsal

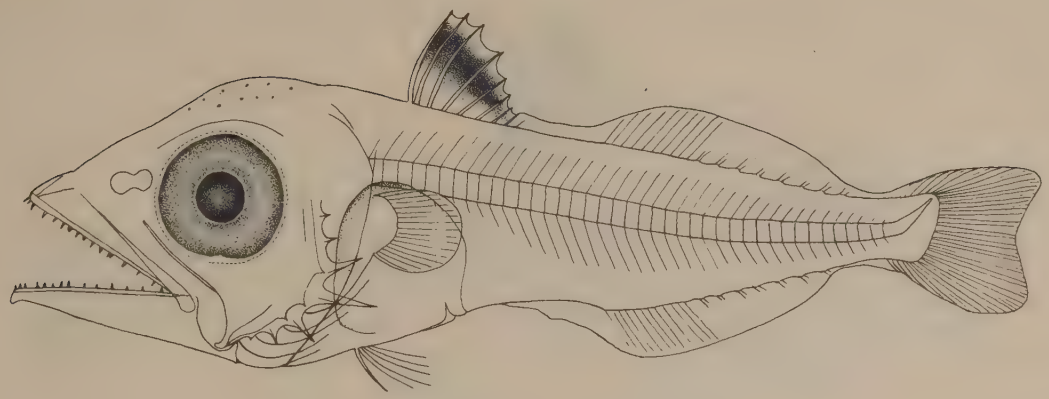


FIGURE 7.—*Neothunnus macropterus*, 7.76 mm.

fin. In the smaller specimen (6.19 mm.) the dark pigmentation is confined to the interradial membrane between two rays, but on the larger (6.7 mm.) the pigmentation is found on two interradial membranes.

A specimen of 7.76 mm. fork length (fig. 7) closely approaches the juvenile form in general appearance. The body depth has increased, especially posterior to the anal opening. The head remains disproportionately large compared to the remainder of the body. The snout is slightly longer and more pointed. The end of the maxillary is placed more anteriorly than in the younger stages, and there are seven or eight teeth on each side of both jaws. Seven spines are present on the edge of the preoperculum, two small spines on the vertical edge, three large spines at or near the angle, and two small spines on the horizontal edge. A third small spine has developed on the slight crest lying on the surface of the preoperculum.

The first dorsal has nine high, well-developed rays. The second dorsal and the anal have 10 and 12 rays, respectively. The beginning of seven dorsal and six anal finlets are faintly discernible. The well-developed caudal fin is forked. The median fins are clearly defined, as the membranes connecting them are degenerating. Both the pectoral and ventral fins are well developed.

FIGURE 8.—*Neothunnus macropterus*, 8.55 mm.

FIGURE 9.—*Neothunnus macropterus*, 9 mm.

Specimens of this length are largely white in color and the only pigmentation occurs on the membrane covering the brain, the peritoneum of the abdominal sac, and the first dorsal fin. The central portion of the first dorsal fin is heavily pigmented with small black chromatophores, and only the distal edge and the basal portion remain colorless.

The body and head have become somewhat deeper and heavier in a 9 mm. fork length specimen (fig. 9) which closely resembles the juvenile form in general appearance. The single nasal opening found in smaller specimens has separated into two pores. The anal opening is placed more posteriorly on the body as the abdominal sac is beginning to extend backward. The formation of the vertebrae is complete, and the hypural plate is developing. Two small palatine teeth are present.

The first dorsal fin with 14 rays, is much higher than the second dorsal, and the longest ray almost reaches the origin of the second dorsal when depressed. The remainder of the fins are well developed.

A somewhat larger specimen of 11.65 mm. fork length is illustrated in figure 10. Several minor differences can be seen between this and the specimen shown in figure 9. The first dorsal fin is lower and has an entirely different outline. The ventral fins are inserted somewhat more posteriorly, slightly behind the origin of the first dorsal fin rather than beneath or slightly anterior to it. Instead of three small spines along the horizontal edge of the preop erculum, there are four. It is not known whether these differences are due to growth or whether they represent valid taxonomic differences.

The fin-ray counts of the two dorsal and anal fins place this specimen in one of three species: *Neothunnus macropterus*, *Thunnus orientalis*, or *Kishinouella tonggol*. It was collected from the waters of Luzon Strait, 21°03′ N., 120°52′ E., which is within the known habitat of *T. orientalis* and from an area of unknown abundance of *N. macropterus* and *K. tonggol*. However, in spite of the possibility that this specimen may be other than *N. macropterus*, it is placed in that species until additional collections more clearly define the related forms.

Specimens of larval *Neothunnus macropterus* longer than 7.5 mm. can be distinguished from the other species described here by the large, highly developed, and almost entirely black first dorsal fin. However, it is quite possible that the unknown larval forms of *Thunnus orientalis*, *Thunnus germo*, and *Kishinouella tonggol* are similar to those of *N. macropterus* and have been included with it. Ehrenbaum (1924) could not separate successfully the larvae of the two common thunnids of the Mediterranean, *Thunnus thynnus* and *Thunnus germo*, on specific differences; therefore, he gave the species name of the more abundant adult to the more abundant larvae.

The early and rapid development of the first dorsal fin, which is first evident in specimens of slightly

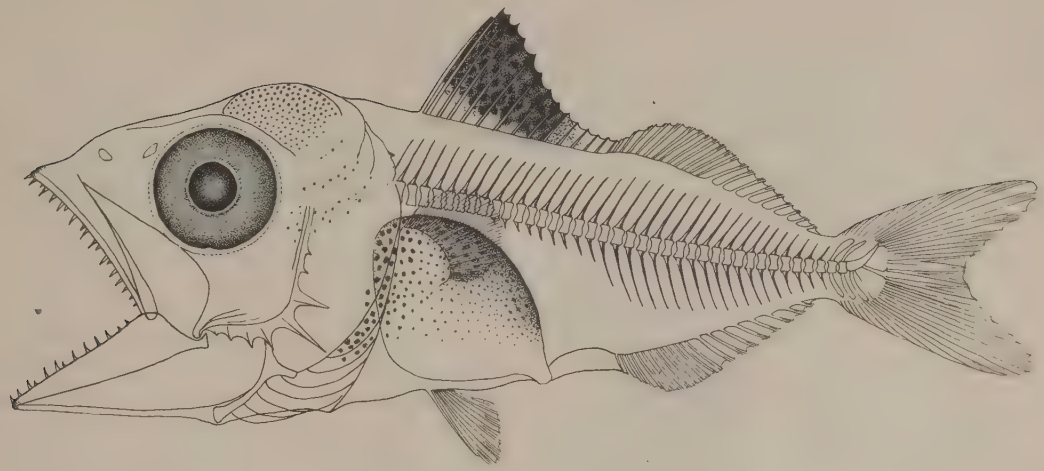


FIGURE 10—*Neothunnus macropterus*, 11.65 mm.

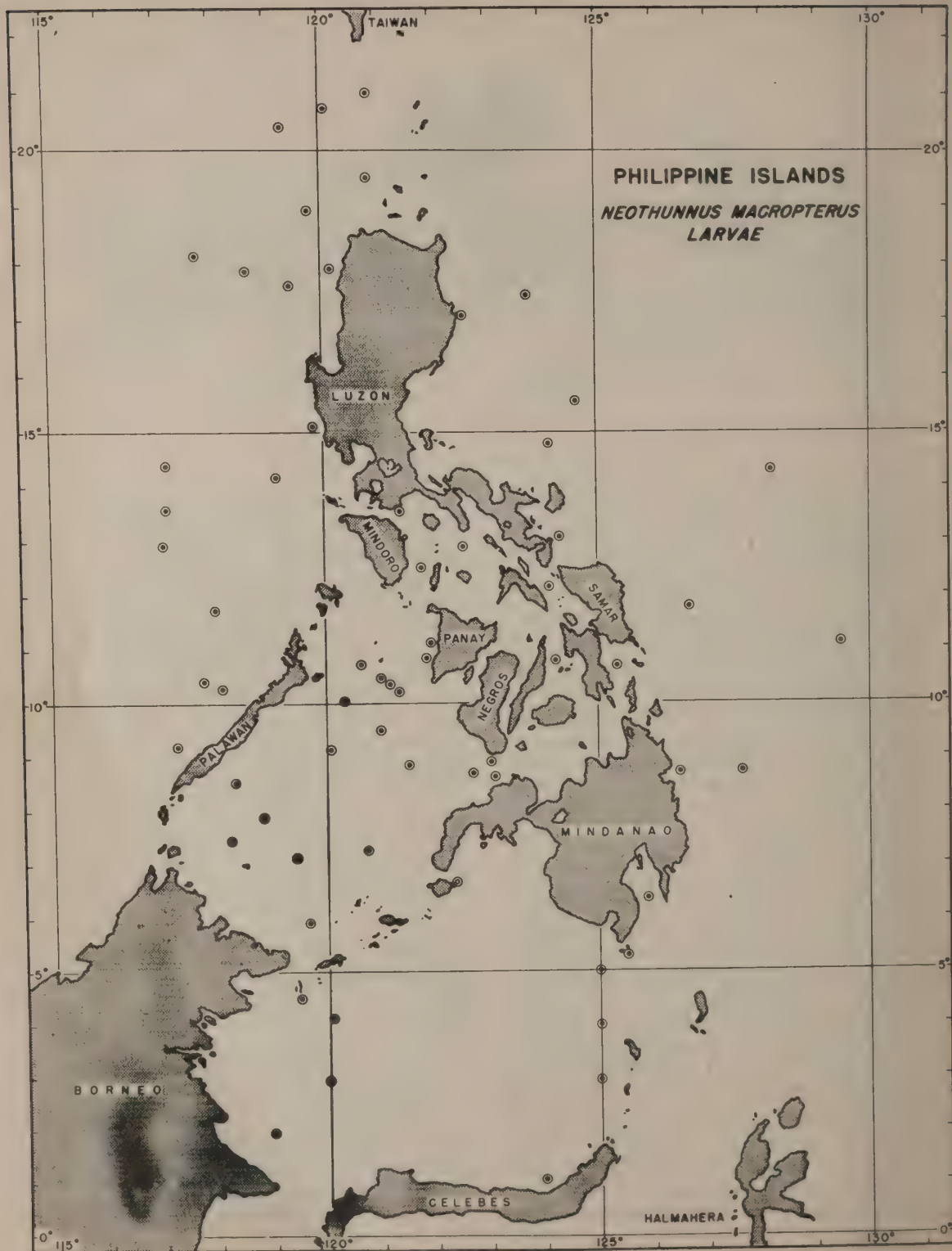
less than 6 mm. length, and the entire absence of black chromatophores on the surface of the body are the principal characters that distinguish this species from about 5.75 to 7 mm. in length. Among the other species described here, only in *Euthynnus yaito* does the first dorsal fin begin to develop at this size. However, *Neothunnus macropterus* can be distinguished from *E. yaito* by the greater height and number of the first dorsal rays present in specimens of equal size. Also, the presence of an irregular series of small pigment spots on the posterior portion of the dorsal and ventral midlines of *E. yaito* is in contrast to the complete lack of pigmented areas on the body of *N. macropterus*.

Few specific characters serve to identify small specimens of *Neothunnus macropterus* 5.5 mm. or smaller, and it is at this size that the judgment and experience of the investigator is used to the greatest extent. The color of these small specimens is white and no pigment spots are present on the surface of the body. The head is moderate in size, and the mouth, only slightly oblique, is not large in relation to the head size. The median fin membranes are moderately to well developed. On many specimens of *Katsuwonus pelamis*, the small pigment spot is absent from the ventral midline of the caudal peduncle, and the surface of the body is colorless as in *N. macropterus*. However, it is distinguished from *K. pelamis* by the very large head, long, pointed snout, and wide gape. Both *Euthynnus* and *Auxis* have some body pigmentation along the posterior portion of the ventral midline and, occasionally, along the dorsal midline in the region of the caudal peduncle.

TABLE 9.—*Monthly catch of larval* Neothunnus macropterus *taken in Philippine waters, 1947–49*

Month	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
1947					
October	21	3	14.2	8	0.38
December	15	5	33.3	76	5.05
1948					
February	10				
March	18	2	11.1	7	.39
April	27	3	11.1	6	.22
June	27	4	14.7	8	.30
July	25	1	4.0	1	.04
August	17	1	5.9	1	.06
September	28	4	14.3	4	.14
1949					
January	30	2	6.7	2	.07
February	43	2	4.4	2	.04
May	38	6	15.8	20	.53
June	25	1	4.0	1	.04
July	18	4	22.2	18	1.00
August	50	14	28.0	31	.62
September	35	7	20.0	34	.97
October	20	2	10.0	2	.01
November	16	2	12.5	6	.37
All	463	63	13.6	227	0.49

Larval *Neothunnus macropterus* were taken every month of the year. Unfortunately, none of the spawning areas were reexamined periodically, consequently, variations in abundance of larvae from any one area throughout the year are not known.


PHILIPPINE ISLANDS
NEOTHUNNUS MACROPTERUS
LARVAE
TAIWAN
LUZON
MINDORO
SAMAR
PANAY
NEGROS
PALAWAN
MINDANAO
BORNEO
CELEBES
HALMAHERA
115°
120°
125°
130°
20°
15°
10°
5°
0°

However, based upon the present collections, the period of least catch occurred during January and February. The average catch of all 83 tows made during the 2 months was 0.05 specimen, while only 4 tows (4.8 percent) captured larvae. December yielded the largest average catch for the 15 tows made, 5.06 larvae per tow. Five tows (33.3 percent) contained *Neothunnus* larvae. May, July, August, and September are also indicated as months when *Neothunnus* larvae are more abundant.

Ripening adults of this species were taken by trolling operations throughout the year from the research vessel *Spencer F. Baird* (Wade, 1950b). In addition, a few specimens, with what were judged to be ripe gonads, were captured. A study of the gonad condition of this species made from troll-caught fish suggests that the spawning period is protracted. The present collection of larval forms indicates that this species spawns to some degree throughout the year, and that from March through December it is more intensive than during January and February. The greatest intensity of spawning seems to occur from May through September.

TABLE 10.—*Hourly summary of larval* Neothunnus macropterus *collected in Philippine waters, 1947–49*

Hour	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
0600–0659	26	3	11.5	5	0.19
0700–0759	18	3	16.7	30	1.66
0800–0859	19	4	21.1	13	.68
0900–0959	23	2	8.7	4	.17
1000–1059	15	1	6.7	1	.07
1100–1159	18	0	0	0	.00
1200–1259	22	2	9.1	4	.18
1300–1359	19	2	10.5	7	.37
1400–1459	21	7	33.3	28	1.33
1500–1559	16	2	12.5	4	.25
1600–1659	31	8	25.2	29	.94
1700–1759	22	2	9.1	11	.50
1800–1859	16	4	25.0	14	.88
1900–1959	21	3	14.3	5	.24
2000–2059	16	2	12.5	17	1.06
2100–2159	23	2	8.7	28	1.23
2200–2259	21	3	14.3	10	.48
2300–2359	17	4	23.5	3	.18
0000–0059	18	1	5.6	1	.06
0100–0159	13	2	15.4	2	.15
0200–0259	21	4	19.1	4	.19
0300–0359	15	1	6.7	2	.13
0400–0459	13	2	15.4	3	.23
0500–0559	18	4	22.2	4	.22

During the daylight hours of 0600 to 1800, 250 larval-fish and plankton tows were made. At night 212 tows were made between 1800 to 0600 hours. Thirty-six hauls (14.4 percent of the day operations) captured larval *Neothunnus macropterus*, and 32 of the night tows (14.5 percent) also caught larvae. During the day an average of 0.54 specimen was taken for all operations, and during the hours of darkness an average of 0.44 specimen was collected.

The hours 0900 to 1300 yielded the poorest catch, and from 2300 to 0400 hours the catch was also low. The greatest hourly average catch of larval *Neothunnus macropterus* was 1.66 specimens for all 18 tows made from 0700 to 0800 hours, although only 16.7 percent of the hauls caught larvae. The highest percentage of successful operations were made from 1400 to 1500 hours when 7 of the 21 tows (33.3 percent) caught larval forms.

The distribution of the percentage of successful operations was almost equal between day and night tows as was the average number of specimens for all day and night hauls. If there is a vertical day and night migration of *Neothunnus macropterus* larvae, it is not evident from these collections. However, during the day it seems likely that fewer larvae are present on the surface from 0900 to 1300 hours than in the early morning or late afternoon. Also, the hours from 2200 to 0400 are less productive of surface fish than the remainder of the night.

KATSUWONUS PELAMIS (Linnaeus)

Family KATSUWONIDAE

Genus *Katsuwonus* Kishinouye

Katsuwonus Kishinouye, 1915, A study of the mackerels, cybiids, tunas. Suisan Gakkai Ho, vol. 1, No. 1, p. 21, type *Scomber pelamis* Linnaeus.

Katsuwonus pelamis (Linnaeus)

The body of *Katsuwonus pelamis* is long and slender in small specimens (fig. 12) of 5 mm. total length. The dorsal and ventral outlines taper gradually and evenly to the end of the caudal fin from the greatest depth which is just posterior to the eye. The head is disproportionately large in relation to the remainder of the body. The head is also bent slightly downward in relation to the body axis. Although this feature does not show clearly in figure 12, it gives the species a characteristic humpbacked appearance. The abdominal sac is small, somewhat rounded, and anteriorly placed. The anal opening is located well forward of the middle of the total length.

FIGURE 11.—Localities in Philippine waters from which the larvae of *Neothunnus macropterus* were collected.

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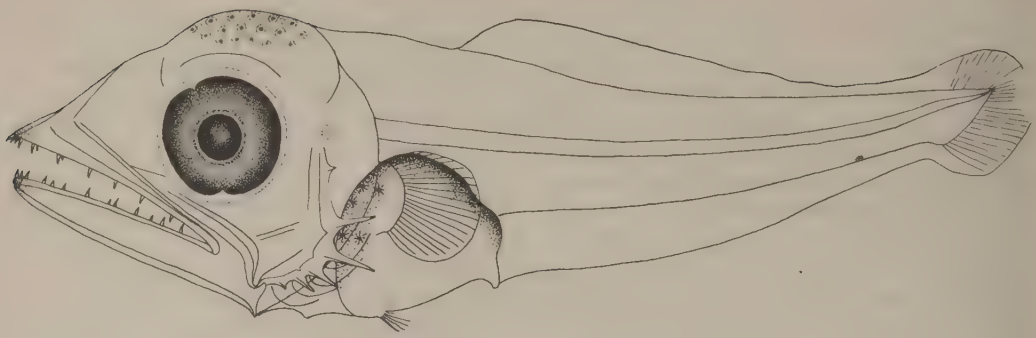

FIGURE 12.—*Katsuwonus pelamis*, 5 mm.

The snout is long and pointed, its tip even with or slightly below the lower edge of the pupil of the eye. The nostrils are not evident. The eye is moderate, its diameter slightly less than the length of the snout. The mouth is large, slightly oblique, and the end of the maxillary reaches a vertical through the posterior edge of the pupil. The lower jaw is slightly included at the tip. There are about eight teeth on each side of both jaws.

TABLE 11.—*Station list of larval* Katsuwonus pelamis *collected in Philippine waters, 1947–49*

Station	Date	Latitude	Longitude	Specimens	
				Number	Size (mm.)
B-17	7 Oct. 1947	10°13′ N.	121°20′ E.	8	5–6.5
B-29	12 Oct. 1947	6°57′ N.	120°15′ E.	4	5.2–5.6
B-35	13 Oct. 1947	9°44′ N.	120°38′ E.	12	4–5.1
B-36	14 Oct. 1947	9°08′ N.	121°12.5′ E.	1	4.7
B-51	5 Dec. 1947	6°57.5′ N.	121°02.5′ E.	3	(1)
B-55	6 Dec. 1947	7°08′ N.	119°27′ E.	2	(1)
B-57	do	8°32′ N.	118°20′ E.	9	4–5.2
B-58	7 Dec. 1947	8°00.5′ N.	117°40′ E.	1	6.4
B-64	10 Dec. 1947	6°48.5′ N.	118°51.5′ E.	9	4.9–6.1
B-65	11 Dec. 1947	5°57.5′ N.	119°09′ E.	14	4.1–6.0
B-66	do	5°57′ N.	119°39.5′ E.	2	5–5.2
B-124	3 Mar. 1948	3° N.	126° E.	3	6–7.6
B-139	9 Mar. 1948	5° N.	123° E.	1	5.5
B-156	10 Apr. 1948	2° N.	121° E.	8	5.5–7.5
B-157	11 Apr. 1948	3° N.	120°55′ E.	3	(1)
B-160	12 Apr. 1948	3° N.	120° E.	9	5–9.1
B-171	15 Apr. 1948	4°08.5′ N.	120°06′ E.	2	5.8–7.0
B-178	17 Apr. 1948	5°05′ N.	121°04.5′ E.	1	5.0
B-186	19 Apr. 1948	6°41′ N.	122°23′ E.	2	5.5–6.0
B-280	25 June 1948	7°16′ N.	119°42′ E.	1	5.9
B-295	10 July 1948	5°57′ N.	119°56′ E.	1	(1)
B-330	30 July 1948	4°45′ N.	119°53′ E.	6	6–7.1
B-338	1 Aug. 1948	1°56.5′ N.	119° E.	1	5.4
B-383	6 Sept. 1948	5° N.	126° E.	2	4.1–4.3
B-396	10 Sept. 1948	2° N.	126° E.	5	4–6.1
B-403	12 Sept. 1948	3° N.	124° E.	2	4.1–4.8
B-411	14 Sept. 1948	2°56′ N.	123°03.5′ E.	2	6–7.7
B-415	15 Sept. 1948	6° N.	123° E.	1	6.0
B-485	22 Jan. 1949	13°24′ N.	119°39′ E.	2	7.1–7.6
B-518	1 Feb. 1949	7°57′ N.	116°31′ E.	1	7.0
B-529	3 Feb. 1949	11°44′ N.	118° E.	5	6.5–8.5
B-536	15 Feb. 1949	13°35′ N.	121°25′ E.	9	5.4–6.8
B 569	21 Feb. 1949	13°07′ N.	124°17′ E.	2	6–7.0
B 675	20 May 1949	17°28′ N.	123°45′ E.	2	6.8–7.2
B-691	24 May 1949	14°30′ N.	122°04′ E.	1	6.1
B-732	30 May 1949	11°50′ N.	126°43′ E.	2	5–5.1
B 796	11 June 1949	8°44′ N.	127°20′ E.	1	7.2
B 941	25 Aug. 1949	5°46′ N.	119°52′ E.	1	7.3
B 991	4 Sept. 1949	8°15′ N.	122°29′ E.	1	5.2
B-998	do	8°53′ N.	121°47′ E.	1	5.0
B 1000	5 Sept. 1949	9°31′ N.	122°15′ E.	5	5.8–6.2
B-1003	do	10°27′ N.	121°51′ E.	1	6.0
B-1028	14 Sept.1949	12°55′ N.	122°30′ E.	3	(1)
B-1057	12 Oct. 1949	13°09′ N.	125°13′ E.	1	5.0
B-1105	16 Nov. 1949	12°49′ N.	124°24′ E.	1	6.9

[1] Distorted.

Six spines are developed along the edge of the preoperculum: Two long slender spines at the preopercular angle, one a small spine on the vertical edge of the preoperculum, and 3 small spines along the horizontal edge. There are 3 small blunt spines along a slight crest on the surface of the preoperculum. The vertebrae are not developed and the long, slender urostyle is bent slightly upward.

The pectoral fins are present, as are small, undeveloped ventrals. The median fins are not formed, but are represented by a well-developed membrane extending backward along the dorsal midline from above the pectoral base, around the caudal end of the body, and anteriorly along the ventral midline to the anal opening. No fin rays are evident, but faint vertical streaks can be seen in the membrane of the caudal region.

The body color of formalin-preserved specimens is white. The membrane covering the brain is pigmented with scattered, small black chromatophores. The peritoneum of the abdominal sac is densely covered dorsally and anteriorly with small black pigment spots. A small, faintly pigmented area is sometimes found on the side of the head directly behind the eye. In most specimens there is one small black chromatophore on the ventral midline immediately anterior to the caudal peduncle. The tips of the jaws are slightly pigmented.

Only slight changes have taken place by the time this species has reached about 7 mm. total length

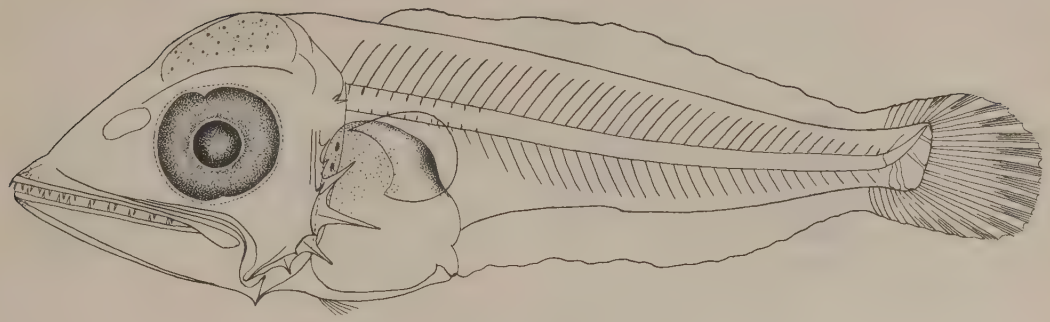

FIGURE 13.—*Katsuwonus pelamis*, 7.15 mm.

(fig. 13). The general appearance of the body remains much the same, although it is slightly deeper and heavier, and the head remains disproportionately large. A single large nostril can be seen on each side of the long pointed snout. Each side of both jaws bears 10 to 12 small pointed teeth. The beginnings of the anterior vertebrae can be seen faintly, and the hypural plate has begun to develop. All of the fins remain undeveloped except for the caudal, which by now has well-defined rays. The color pattern remains the same.

The pectoral and ventral fins are moderately developed. The caudal fin is well developed and slightly forked. The first dorsal has 9 short rays, but the rays and finlets of the second dorsal and anal fins can barely be discerned. There are 11 second-dorsal rays and 5 finlets, and 10 anal rays and 5 finlets developed at this stage. The median fin membrane is degenerating between the two dorsal fins on the caudal peduncle, and between the anal fin and the anal opening.

The body color of formalin-preserved specimens is white or light tan. The usual dark pigmentation is present on the head, on the abdominal sac, and on the ventral midline immediately anterior to the caudal peduncle.

Specimens of approximately 9 mm. fork length (fig. 15) are quite similar to those of 8 mm. The body is more robust and is approaching the juvenile form. The head remains large in relation to the rest of the body. The snout is somewhat longer and more pointed. The single nostril on each side of the snout has almost completely divided into an anterior and posterior nostril. The mouth is large, and there are from 16 to 18 teeth on each side of both jaws.

The development of this species is seemingly quite rapid between the 7.15 (fig. 13) and the 8.2 mm.

FIGURE 14.—*Katsuwonus pelamis*, 8.2 mm.

FIGURE 15.—*Katsuwonus pelamis*, 9.1 mm.

fork length specimens (fig. 14), which latter was selected to represent the next stage of development. The body is deeper and heavier, becoming more typically fish-like in appearance. The head remains large and is bent downward in relation to the body axis. The anal opening is placed more posteriorly toward the center of the body.

The long pointed snout has a single nostril on each side which is becoming slightly constricted at the center. The eyes are large, the diameter slightly less than the length of the snout. The mouth is large, slightly oblique, with 10 to 13 teeth on each side of both jaws. Three or four palatine teeth are present. The maxillary extends posteriorly to a vertical line drawn midway between the posterior edge of the pupil and the posterior edge of the eye. The lower jaw is slightly included at the tip.

In the 8.2-mm. specimen (fig. 14) the edge of the preoperculum bears 7 spines. The spine at the angle is long and slender and extends downward and backward over the anterior part of the abdominal sac. The spine immediately above that at the angle of the preoperculum is slightly shorter and heavier and extends slightly upward and backward. There are two small spines on the vertical edge of the preoperculum and three along the horizontal edge. A slight crest on the surface of the preoperculum has three small spines. The developing vertebrae can be faintly seen anteriorly, as can the hypural plate at the base of the caudal.

The 9-mm. specimen (fig. 15) has eight spines along the edge of the preoperculum: Three small spines on the vertical edge, two long slender spines at the angle, and three small spines along the horizontal edge. A slight crest on the surface of the preoperculum has three small spines, and two small temporal spines are present. The vertebrae and the hypural plate are well developed.

The first dorsal has 14 rays, the second dorsal has 15 rays and 8 finlets which can be seen faintly. The anal fin has 13 rays and 7 barely discernible finlets.

The body color remains the same as in smaller specimens with the usual black pigmentation on the head, abdominal sac, and ventral midline. In addition, the first dorsal fin possesses a few scattered small pigment spots on the outer portion of the membrane.

No difficulty was experienced in separating the larvae of *Katsuwonus pelamis* from the larvae of other species described in this publication. In all sizes the disproportionately large head in relation to the remainder of the body serves to identify *K. pelamis* almost positively. In addition, several characteristics of the head, such as the long pointed snout and large gape, are useful in determining the species. The horizontal axis of the head is bent slightly downward in relation to the body axis, which gives this species a somewhat humpbacked appearance. In many, if not most, specimens, one small black pigment spot is present along the ventral midline in the region of the caudal peduncle. Only one other species described in this publication, *Neothunnus macropterus*, has a body surface without pigmentation. The large head of *K. pelamis* separates it from *N. macropterus* when the pigment spot is absent in the former.

Kishinouye (1926) described six specimens, 3 to 6 mm. in length, of what he considered to be *Katsuwonus pelamis*. The specimens were collected during late May and early June 1924, from off Satsunan Shichito, Japan (lat. 28° to 31° N., long. 129° to 131° E.). Two of these specimens, which in his opinion had just hatched, were 3 mm. long. Illustrations are not available in the translation of Kishinouye's work consulted, but from the description, at least one of the specimens with a dorsal and ventral row of chromatophores on the body does not seem to have been *K. pelamis*. The three 4 mm. specimens and the single 6 mm. example quite probably were *K. pelamis*, as he noted the large head and single large chromatophore on the ventral midline just anterior to the caudal peduncle. The smallest specimen which Kishinouye could identify positively was 26 mm. long and was taken from the stomach of an adult *K. pelamis*. In fact, most of his juveniles were taken from the stomachs of adult *K. pelamis* and other pelagic fishes.

TABLE 12.—*Monthly catch of larval* Katsuwonus pelamis *taken in Philippine waters, 1947–49*

Month	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
1947					
October	21	4	19.0	25	1.19
December	15	7	46.7	40	2.66
1948					
February	10				
March	18	2	11.1	4	.22
April	27	6	22.1	25	.92
June	27	1	3.7	1	.04
July	25	2	8.0	7	.28
August	17	1	5.9	1	.06
September	28	5	17.8	12	.43
1949					
January	30	1	3.3	2	.06
February	43	4	9.3	17	.39
May	38	3	7.9	5	.13
June	25	1	4.0	1	.04
July	18				
August	50	1	2.0	1	.02
September	35	5	14.3	11	.31
October	20	1	5.0	1	.05
November	16	1	6.2	1	.06
All	463	45	9.7	154	0.33

Specimens of larval *Katsuwonus pelamis* were collected throughout the year as a basis for the present study, with the greatest numbers occurring during the fall, winter, and spring months. The summer months were the least productive; however, it should be noted that larval specimens of this species were never abundant. The largest average number of specimens collected for all operations occurred in December, when an average of 2.66 *K. pelamis* larvae were caught in a total of 15 tows, with 7 tows (46.7 percent) successful. August produced the least *K. pelamis* larvae, when only 2 specimens were captured in a total of 67 hauls for an average of 0.03 specimen. Only 3 percent, or 2 hauls out of the 67, caught specimens.

The capture of the larvae of *Katsuwonus pelamis* throughout the year confirms a previous conclusion, based upon an analysis of troll-caught adults (Wade, 1950b), that this species spawns throughout the year. Although the collections furnish no positive information about the fluctuations in abundance of larvae in any particular area throughout the year, there are indications that the period from September to April, inclusive, may be the principal spawning period. However, the periods of low catch may have been due to operations in areas where *K. pelamis* never spawns in any abundance, and larvae may have been abundant in other areas not sampled.

An outstanding characteristic of the collection of larval *Katsuwonus pelamis* is the great difference between the results of the day and night tows. Only 3.6 percent, or 9 of the 250 day tows, captured larvae, and only 15 specimens were taken for an average of 0.06 specimen for all tows. Night tows, on the other hand, were 17 percent successful, as 36 out of 212 operations caught 139 larvae for an average of 0.66 specimen for the total number of tows made. This indicates a downward migration below the surface during the day and a return to the surface at night. Since only surface tows were made, it is not known to what depths the larvae of this species descend.

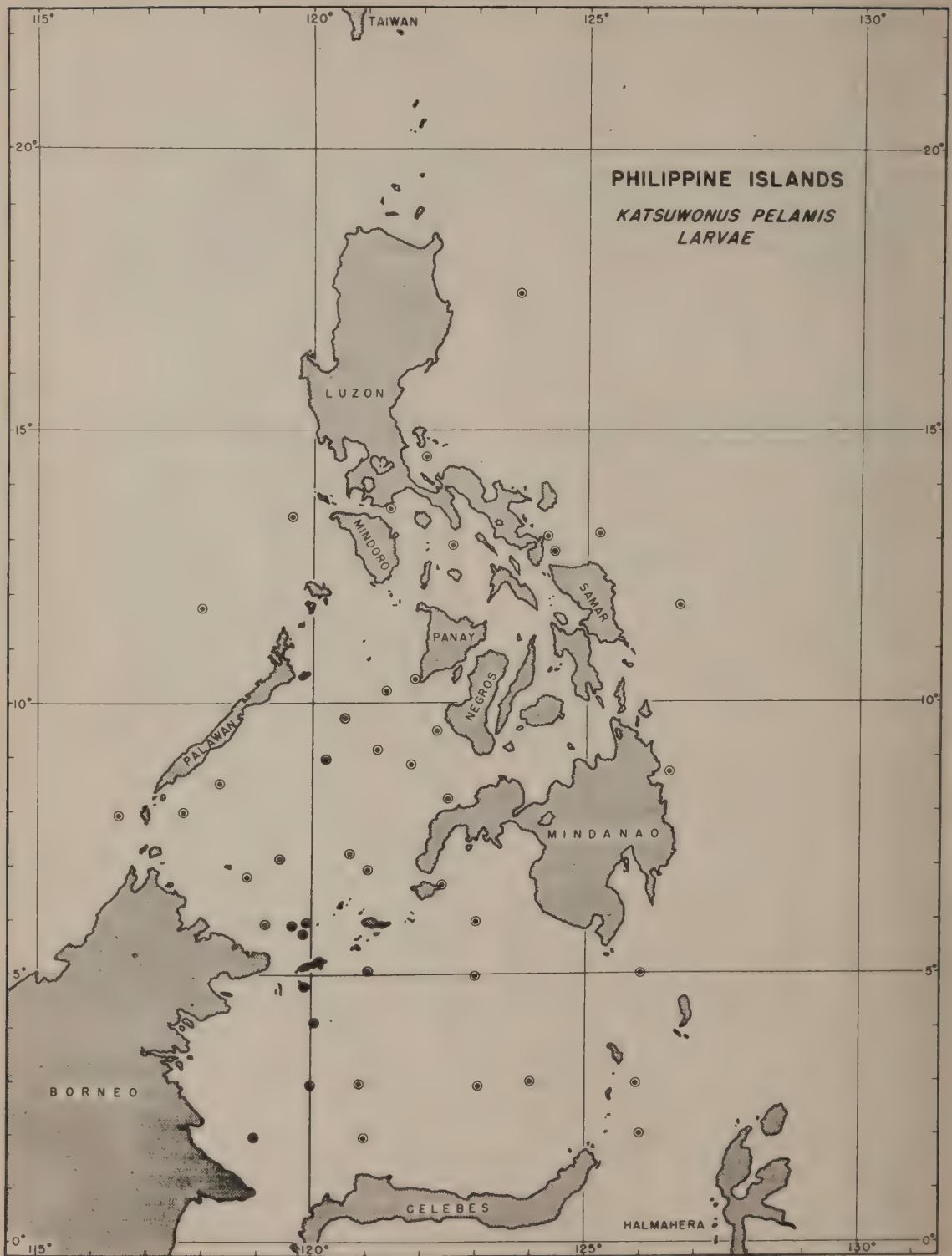
PHILIPPINE ISLANDS
KATSUWONUS PELAMIS
LARVAE
TAIWAN
LUZON
MINDORO
SAMAR
PANAY
NEGROS
PALAWAN
MINDANAO
BORNEO
CELEBES
HALMAHERA
115°
120°
125°
130°
20°
15°
10°
5°
0°

TABLE 13.—*Hourly summary of larval* Katsuwonus pelamis *collected in Philippine waters, 1947–49*

Hour	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
0600–0659	26	2	7.71	3	0.11
0700–0759	18	2	11.10	5	.28
0800–0859	19	1	5.27	1	.05
0900–0959	23	1	4.35	1	.04
1000–1059	15				
1100–1159	18				
1200–1259	22				
1300–1359	19				
1400–1459	21				
1500–1529	16	1	6.26	1	.06
1600–1659	31	2	6.45	4	.13
1700–1759	22				
1800–1859	16	2	15.50	3	.19
1900–1959	21	4	19.00	10	.47
2000–2059	16	1	6.26	9	.56
2100–2159	23	4	15.40	19	.83
2200–2259	21	2	9.50	20	.95
2300–2359	17	1	5.27	1	.06
0000–0059	18	4	22.20	9	.50
0100–0159	13	4	30.70	13	1.00
0200–0259	21	6	28.50	32	1.52
0300–0359	15	4	26.60	7	.47
0400–0459	13	1	7.70	2	.15
0500–0559	18	3	16.60	14	.78

EUTHYNNUS YAITO (Kishinouye)

Family KATSUWONIDAE

Genus *Euthynnus* Lütken

Euthynnus Lütken, ms. in Jordan and Gilbert, 1882, Syn. Fish North America, Bull. 16, U. S. Nat. Mus., p. 429.

Euthynnus yaito (Kishinouye)

The smallest recognizable specimen of *Euthynnus yaito* in the collections is 3.7 mm. total length (fig. 17). The specimen is long and slender, especially posterior to the anal opening, and the head is not large in relation to the remainder of the body. The greatest depth is at a point defined by a vertical line drawn through the center of the eye. The dorsal and ventral outlines taper gradually to the end of the urostyle. The abdominal sac is small, somewhat triangular in shape, and placed anteriorly. The anal opening is located well forward of the center of the horizontal axis of the body.

The snout is short, about two-thirds of the eye diameter in length. The nostrils are not evident. No teeth can be seen in the large, slightly oblique mouth. The end of the maxillary reaches to a vertical line drawn through the pupil of the rather large eye.

TABLE 14.—*Station list of larval* Euthynnus yaito *collected in Philippine waters, 1947–49*

Station	Date	Latitude	Longitude	Specimens	
				Number	Size (mm.)
B-32	13 Oct. 1947	9°49′ N.	119°22.5′ E.	1	8.2
B-35	do	9°44′ N.	120°38′ E.	4	4.9–6.0
B-37	14 Oct. 1947	8°32′ N.	121°48.5′ E.	1	5.4
B-47	3 Dec. 1947	9°03′ N.	118°58′ E.	3	5.2–7.2
B-58	7 Dec. 1947	8°00.5′ N.	117°40′ E.	45	4.9–9.0
B-64	10 Dec. 1947	6°48.5′ N.	118°51.5′ E.	1	(1)
B-101	23 Feb. 1948	7° N.	123°49′ E.	15	4–6.1
B-112	26 Feb. 1948	6°22′ N.	125°53′ E.	1	6.5
B-120	1 Mar. 1948	3° N.	125° E.	1	5.2
B-123	2 Mar. 1948	2° N.	126° E.	7	4.8–6.3
B-124	3 Mar. 1948	3° N.	126° E.	2	5–5.5
B-133	7 Mar. 1948	1°06.3′ N.	123°59′ E.	1	5.0
B-138	8 Mar. 1948	4° N.	123° E.	1	6.6
B-154	10 Apr. 1948	1°29′ N.	121° E.	3	4.9–5.8
B-156	do	2° N.	121° E.	5	5.2–6.5
B-178	17 Apr. 1948	5°05′ N.	121°04.5′ E.	9	5.5–9.1
B-309	14 July 1948	7°26.5′ N.	116°55′ E.	7	6–8.0
B-333	31 July 1948	4° N.	118°44′ E.	1	7.0
B-339	1 Aug. 1948	1° N.	119°08′ E.	18	4.2–6.5
B-345	3 Aug. 1948	4°05′ N.	120°59′ E.	1	8.8
B-353	5 Aug. 1948	3° N.	122° E.	16	5.2–7.7
B-379	5 Sept. 1948	5° N.	125° E.	11	4–7.9
B-396	10 Sept. 1948	2° N.	126° E.	2	(1)
B-400	12 Sept. 1948	4° N.	125° E.	1	5.1
B-403	do	3° N.	124° E.	1	5.1
B-407	13 Sept. 1948	1°13′ N.	123° E.	2	4–4.5
B-415	15 Sept. 1948	6° N.	123° E.	8	5–7.0
B-484	21 Jan. 1949	13°35′ N.	120°07′ E.	25	5–9.9
B-485	22 Jan. 1949	13°24′ N.	119°39′ E.	13	5–7.8
B-490	23 Jan. 1949	12°50′ N.	120°37′ E.	7	5.1–7.4
B-494	24 Jan. 1949	12°24′ N.	120°52.5′ E.	18	5.7–7.0
B-495	do	12°07′ N.	121°04.5′ E.	6	7.4–10.1
B-498	do	11°45.3′ N.	121°11.2′ E.	10	6–8.3
B-500	25 Jan. 1949	10°52.5′ N.	121°51.5′ E.	7	8.2–11.0
B-502	do	10°36′ N.	120°37′ E.	3	6.5–8.0
B-503	do	10°19′ N.	120°03′ E.	34	5–7.1
B-507	27 Jan. 1949	7°33′ N.	120°29′ E.	1	6.1
B-510	28 Jan. 1949	6°56′ N.	118°14′ E.	17	4.7–8.9
B-518	1 Feb. 1949	7°57′ N.	116°31′ E.	1	(1)
B-529	3 Feb. 1949	11°44′ N.	118° E.	298	4.5–10.0
B-532	14 Feb. 1949	13°47′ N.	120°35′ E.	2	6.8–7.0
B-533	do	13°35′ N.	120°32′ E.	10	7.6–10.0
B-536	15 Feb. 1949	13°35′ N.	121°25′ E.	19	4.5–6.5
B-540	do	12°37.5′ N.	121°32.5′ E.	302	6–8.1
B-543	16 Feb. 1949	12°17′ N.	121°30′ E.	24	4–5.5
B-544	do	12°06′ N.	121°40′ E.	8	4.9–9.5
B-552	17 Feb. 1949	10°39′ N.	123°42′ E.	4	5.3–9.1
B-553	do	10°40′ N.	123°32.5′ E.	12	6–7.9
B-554	18 Feb. 1949	9°46′ N.	123°14.8′ E.	1	9.6
B-684	22 May 1949	16°07.5′ N.	122° E.	1	5.0
B-691	24 May 1949	14°30′ N.	122°04′ E.	1	6.8
B-696	do	15°35′ N.	124°40′ E.	3	5.8–6.6
B-888	6 Aug. 1949	16°21′ N.	120°12′ E.	5	5.8–6.6
B-943	26 Aug. 1949	5°10′ N.	119°25′ E.	135	7.1–11.0
B-946	do	5°01.5′ N.	119°38′ E.	10	7–9.9
B-948	do	6° N.	119°15′ E.	2	(1)
B-1003	5 Sept. 1949	10°27′ N.	121°51′ E.	2	5–6.0
B-1007	do	11°44′ N.	121°48′ E.	1	3.3
B-1114	19 Nov. 1949	11°56′ N.	123°19′ E.	7	5.9–6.2
B-1117	20 Nov. 1949	11°33′ N.	120°51′ E.	7	5–7.1

[1] Distorted.

There are three spines on the edge of the preoperculum. The center spine is the largest, flanked above by a slightly shorter and heavier spine, and below by a short blunt spine. The center spine extends obliquely downward and backward over the anterior part of the abdominal sac, while the upper spine extends slightly upward and backward. Two small spines can be seen on a slight crest on the surface of

FIGURE 16.—Localities in Philippine waters from which larval *Katsuwonus pelamis* were collected.

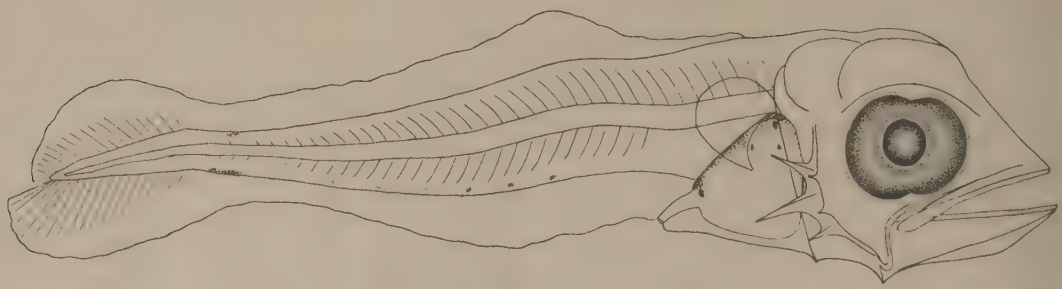

FIGURE 17.—*Euthynnus yaito*, 3.7 mm.

the preoperculum. The vertebrae cannot be distinguished, and the urostyle is long and slender.

Although the pectoral fin is present, the fin rays are not evident, and the ventral fins are absent. No median fins are present, but they are represented by a median-fin membrane extending backward along the dorsal midline from above the pectorals, around the posterior end of the body, and forward along the ventral midline to the anal opening. Although no fin rays are developed, faint vertical streaks can be seen in the membrane of the caudal region.

The body color is white in formalin-preserved specimens. No pigment is present on the head. The abdominal sac is pigmented dorsally and anteriorly with numerous, closely placed, small black chromatophores. An irregularly placed series of small black chromatophores, varying in number from two to seven, can be seen along the ventral midline in the region of the anal fin and caudal peduncle. Some specimens also possess several scattered black chromatophores along the posterior part of the dorsal midline.

A specimen 4.35 mm. in total length (fig. 18) very closely resembles the description of the preceding 3.7 mm. specimen.

Considerable development has taken place by the time this species reaches a total length of 6.5 mm. (fig. 19). The body is deeper and more robust, especially posteriorly. The head is larger and more pronounced in relation to the rest of the body, but the abdominal sac and the position of the anal opening have not changed to any extent.

The snout is long and pointed, its length slightly greater than the diameter of the eye. A large nostril can be seen on each side of the snout. The mouth is large, slightly oblique, and there are 9 to 10 teeth on each side of both jaws. The end of the maxillary reaches to a vertical drawn through the posterior margin of the pupil.

The edge of the preoperculum has seven spines: Two elongated slender spines at the angle (the lower and the longer is more slender), two small spines on the vertical edge, three along the horizontal edge. There are three small spines along a slight crest on

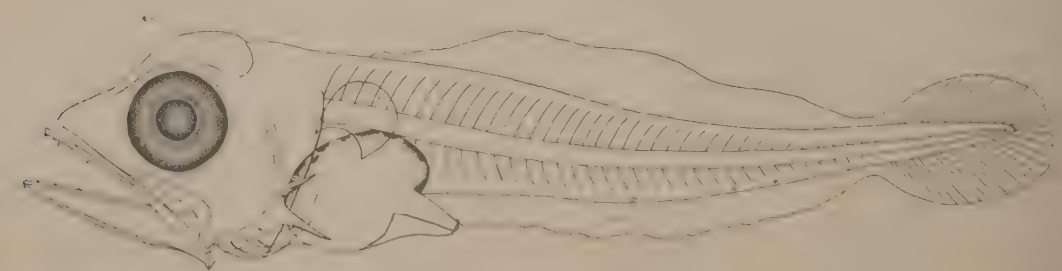

FIGURE 18.—*Euthynnus yaito*, 4.35 mm.

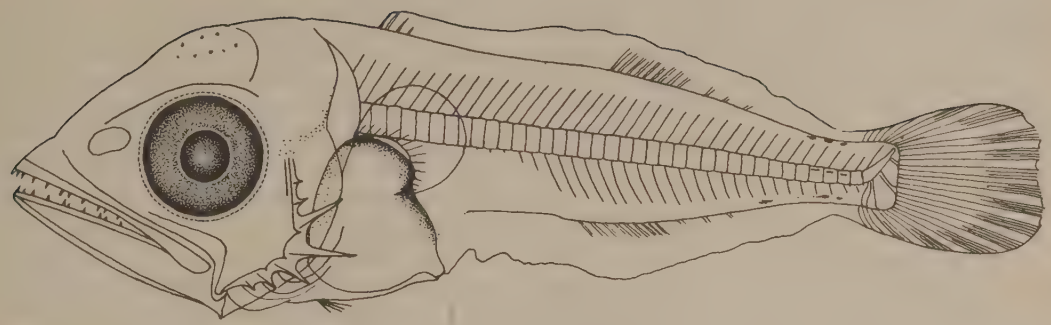

FIGURE 19.—*Euthynnus yaito*, 6.5 mm.

the surface of the preopercle. The vertebrae and the hypural plate can be faintly seen in cleared and stained specimens.

Both the pectoral and ventral fins are present but are largely undeveloped. Four small rays can be seen in the anterior portion of the first dorsal fin, while nine rays and three finlets can be traced faintly in both the second dorsal and the anal fins. The caudal fin is well developed, its posterior edge slightly concave.

The body color of formalin-preserved specimens is pale cream or white. A few scattered dark pigment spots are present on the membrane covering the brain and there is slight irregular pigmentation on the side of the head behind the eye. The peritoneum of the abdominal sac is densely pigmented dorsally with small black chromatophores. A faintly marked, irregular row of dark pigment lies along the posterior portion of the ventral midline. Several small chromatophores occur along the dorsal midline in the region of the caudal peduncle.

Only slight changes take place between 6.5 (fig. 19) and 7.5 mm. fork length (fig. 20) specimens. The body is more robust in the latter, and the head retains the same relative size as in the smaller specimen. The abdominal sac is slightly elongate, and the anal opening has moved more posteriorly. The snout is somewhat longer and more pointed. The single nostril on either side of the snout is beginning to constrict at its middle and to divide

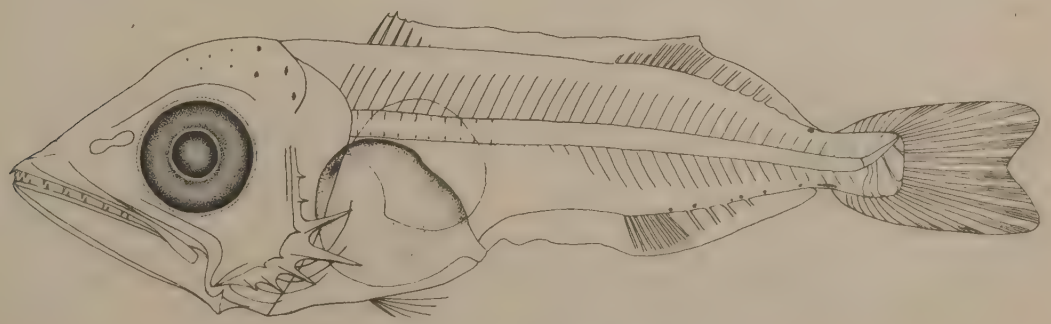

FIGURE 20.—*Euthynnus yaito*, 7.5 mm.

into two openings. The mouth and number of teeth in each jaw remain much the same.

There has been no change in the number of preopercular spines. The vertebrae in the 7.5 mm. specimen cannot be accurately distinguished, but the hypural plate is beginning to develop.

Poorly developed pectoral and ventral fins are present. Six short spines can be distinguished in the anterior portion of the first dorsal, and 11 rays and five finlets can be seen in the second dorsal fin. There are eight rays and four finlets in the anal fin. The caudal fin is well developed and slightly forked.

The color remains the same as in the smaller specimens except for the more heavily pigmented abdominal sac.

A specimen of 10.5 mm. fork length (fig. 21) closely resembles the juvenile form in general appearance. The body is heavy and robust, and the head large and well developed. The abdominal sac is becoming more elongated, and the anal opening is in a more posterior position, immediately anterior to the middle of the body.

The head of the 10.5 mm. specimen retains the same features as the 7.5 mm. specimen with the following exceptions: The single nostril on each side of the snout is becoming more constricted at its center and will shortly separate into an anterior and a posterior nasal opening; the number of teeth on each side of both jaws has increased from 11 to 13; 2 small temporal spines can be seen on each side of the nape; and both the vertebrae (total 39) and the hypural plate are well developed.

The first dorsal fin possesses 8 moderate-sized spines on the anterior portion. Nine rays and 8 finlets can be seen in the second dorsal, and 10 rays and 7 finlets in the anal fin. The caudal fin is well developed and slightly forked.

The general body color remains the same as in the small specimens, except that a heavier concentration of chromatophores appears on the membrane covering the brain, and a few scattered small spots of black pigment are present on the interradial membranes of the first dorsal fin.

Large specimens of larval *Euthynnus yaito*, approximately 9 to 10.5 mm. fork length, can be identified by the moderately developed first dorsal fin, which remains united with the second dorsal by a well-developed median fin-membrane. A short, irregular row of small black pigment spots is located along the base of the anal finlets and extends posteriorly to the caudal peduncle. A similar row of pigment spots usually is present along the base of the dorsal finlets and caudal peduncle. In both, the length and intensity of these pigmented rows vary considerably. The dorsal row may be reduced to one or two small chromatophores on the caudal peduncle, and occasionally they may be absent.

Quite similar at first glance to *Auxis* sp. (?), *Euthynnus yaito* larvae about 10 mm. long can be identified by the presence of the median membrane between the first and second dorsal fins, the larger, less posteriorly truncated head with a longer, more pointed snout, and a less obliquely placed mouth. The poorly developed first dorsal fin, smaller head, and body pigmentation separates *E. yaito* from *Katsuwonus pelamis*. The highly developed first dorsal fin, which is almost entirely dark, distinguishes specimens of *Neothunnus macropterus* from *E. yaito*.

From 6.5 to 8 mm. fork length, *Euthynnus yaito* is most easily confused with *Auxis* sp. (?), of all the

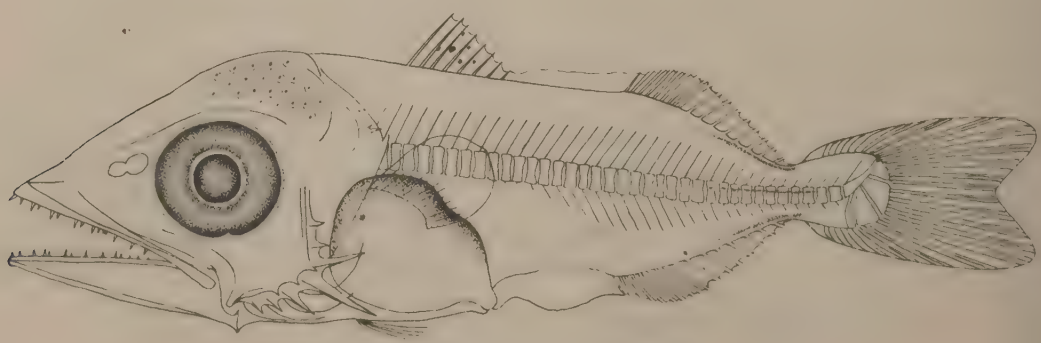

FIGURE 21.—*Euthynnus yaito*, 10.5 mm.

forms described in this bulletin. However, in *E. yaito* several of the rays of the first dorsal fin are present, even in the smaller specimens, while they are absent in *Auxis* sp. (?). The median fin membrane is much more highly developed in *E. yaito*, while it is reduced to a very narrow band in *Auxis* sp. (?) and is sometimes almost entirely absent. Also the head is larger, less truncated posteriorly, and the snout is longer and more pointed. The row of pigment along the posterior portion of the dorsal and ventral midline is present in some degree in both *Auxis* sp. (?) and *E. yaito*, but it seems to be more greatly developed in the former.

Specimens of *Katsuwonus pelamis* can be separated from *Euthynnus yaito* by the larger head, the lack of body pigmentation, and a more highly elevated first dorsal fin among the larger specimens. A highly developed first dorsal fin also distinguishes *Neothunnus macropterus* from *E. yaito* in 6.5 to 8 mm. specimens.

Specimens of *Euthynnus yaito* of 5 mm. or less in length are quite difficult to separate from *Auxis* sp. (?). No median fins are developed in either species, but the median fin membrane of *E. yaito* is much more highly developed than in *Auxis* sp. (?). Although the preopercular spines usually were not considered a good identification character it was found that in *E. yaito* of 5 mm., only three spines have developed on the preopercular edge, while on *Auxis* sp. (?) five spines were formed.

The pigmentation on the head and abdominal sac of *Euthynnus yaito* differs somewhat from *Auxis* sp. (?). In *E. yaito* ordinarily there are no pigment spots in the area over the brain, and the pigment spots of the abdominal sac are numerous and dark. The pigmentation on the head of most specimens of *Auxis* sp. (?) is composed of a few small scattered areas of dark chromatophores, although this configuration varies considerably and may be absent in some specimens. On the abdominal sac of *Auxis* sp. (?) the dark pigmentation is often arranged in a few small scattered areas.

The head is more truncated posteriorly in *Auxis* sp. (?) and the eye is smaller than in *E. yaito*. The development of the abdominal sac seems to be more advanced in *Euthynnus yaito*, but this feature needs to be examined more thoroughly in a larger series of specimens.

Although the larvae of *Euthynnus yaito* were collected throughout most of the year, they occurred most abundantly from November through April. No specimens were taken during June, and net tows in May, July, and October did not produce larvae in any abundance. A small increase was noted during August and September in the number of larvae collected.

TABLE 15.—*Monthly catch of larval* Euthynnus yaito *taken in Philippine waters, 1947–49*

Month	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
1947					
October	21	3	14.2	6	0.28
December	15	3	20.0	49	3.27
1948					
February	10	2	20.0	16	1.60
March	18	5	27.8	12	.67
April	27	3	11.1	17	.63
June	27				
July	25	2	8.0	8	.32
August	17	3	17.6	35	2.06
September	28	6	21.4	25	.89
1949					
January	30	11	36.7	141	4.70
February	43	11	25.6	681	15.70
May	38	3	7.9	5	.13
June	25				
July	18				
August	50	4	8.0	152	3.40
September	35	2	5.7	3	.09
October	20				
November	16	2	12.5	14	.87
All	463	60	13.0	1,164	2.51

Based upon present collections, it appears that the spawning activities of *Euthynnus yaito* take place throughout the year and occur most intensively during the winter and spring months. Spawning seems to be reduced to a minimum during the summer months, except for August, when a slight increase was noted. As in the other species previously discussed, it should be remembered that the data may not present a true picture of the abundance of larvae throughout the entire area. It is entirely possible that at the time the research vessel was working in unproductive areas, larvae in other areas of Philippine waters may have been abundant.

There were considerable differences in the number of *Euthynnus yaito* larvae collected and in the number of successful tows made between the day and night operations. A total of 250 hauls were made during the daylight hours of 0600 to 1800. Sixteen tows (6.4 percent) were successful in capturing 97 larvae with an average of 0.39 specimen for all tows. During the night, 212 hauls were made, and 43 (20.2 percent) were successful. A total of 1,070 specimens were captured during the night operations for an average of 5.05 specimens for all tows. *E. yaito*, like

PHILIPPINE ISLANDS
EUTHYNNUS YAITO
LARVAE
TAIWAN
LUZON
MINDORO
SAMAR
PANAY
NEGROS
PALAWAN
MINDANAO
BORNEO
CELEBES
HALMAHERA
115°
120°
125°
130°
20°
15°
10°
5°
0°

Katsuwonus pelamis, migrates to beneath the surface during the day and returns to the surface at night.

TABLE 16.—*Hourly summary of larval* Euthynnus yaito *collected in Philippine waters, 1947–49*

Hour	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
0600–0659	26	2	7.7	13	0.50
0700–0759	18	1	5.5	7	.39
0800–0859	19	2	10.5	11	.58
0900–0959	23	1	4.4	2	.09
1000–1059	15	1	6.8	24	1.60
1100–1159	18				
1200–1259	22				
1300–1359	19	1	5.3	8	.42
1400–1459	21	3	14.3	13	.62
1500–1559	16	1	6.2	1	.06
1600–1659	31	2	6.5	5	.16
1700–1759	22	2	9.1	13	.59
1800–1859	16	3	18.7	9	.56
1900–1959	21	7	33.3	619	29.50
2000–2059	16	2	12.5	49	3.06
2100–2159	23	4	17.4	55	2.38
2200–2259	21	2	9.5	9	.43
2300–2359	17		7.0		
0000–0059	18	4	22.2	25	1.39
0100–0159	13	5	38.4	14	1.07
0200–0259	21	6	28.5	67	3.19
0300–0359	15	5	33.3	56	3.73
0400–0459	13	3	23.0	3	.23
0500–0559	18	2	22.2	164	9.12

AUXIS SP.(?)

Family KATSUWONIDAE

Genus *Auxis* Cuvier

Auxis Cuvier, 1829, Règne Animal, ed. II, vol. 2, p. 199, type *Scomber rochei* Risso = *Scomber thazard* Lacépède.

Auxis sp. (?)

Two species of the genus *Auxis* occur in Philippine waters (Wade, 1949), but the present collections have provided insufficient data to differentiate between the larvae of the two forms.

The smallest specimen that can be assigned to this genus is 5.1 mm. total length (fig. 23). The body is very slender and elongate, especially in the postanal region. The head is of moderate size and quite short. The abdominal sac protrudes ventrally below the body outline and is placed anteriorly. The anal opening is far cephalad of the middle of the body.

The snout is short and sharply pointed with its dorsal and ventral outlines equally and steeply sloped. The dorsal outline of the head is somewhat bulged over the brain. The eye is large, and its diameter is equal to or greater than the length of the snout. The tip of the snout is at about mid-depth of the head. The mouth is sharply oblique, and the end of the maxillary reaches to a vertical drawn through the center of the pupil. There are from three to five small pointed teeth on each side of both jaws. The lower jaw is slightly included at the tip. The nostrils are not visible.

TABLE 17.—*Station list of larval specimens of* Auxis *sp.* (?) *collected in Philippine waters, 1947–49*

Station	Date	Latitude	Longitude	Specimens	
				Number	Size (mm.)
B–124	3 Mar. 1948	3° N.	126° E.	6	5.8–6.8
B–156	10 Apr. 1948	2° N.	121° E.	1	5.8
B–177	16 Apr. 1948	5° N.	120°30′ E.	1	[1]
B 187	20 Apr. 1948	7° N.	123° E.	1	5.1
B–188	20 Apr. 1948	6°57′ N.	122°25′ E.	1	5.9
B–339	1 Aug. 1948	1° N.	119°08′ E.	2	4.2–4.3
B–486	22 Jan. 1949	12°42.5′ N.	119°32.5′ E.	2	[1]
B–492	23 Jan. 1949	12°32.5′ N.	120°08.5′ E.	1	7.3
B–495	24 Jan. 1949	12°07′ N.	121°04.5′ E.	95	5–11.6
B 497	do	11°31′ N.	120°39′ E.	2	4.6–6.8
B–499	do	11°43′ N.	121°48′ E.	3	[1]
B–501	25 Jan. 1949	10°56′ N.	120°52.5′ E.	3	5.6–5.8
B–502	do	10°36′ N.	120°37′ E.	10	6.1–9.1
B–515	31 Jan. 1949	7°40.5′ N.	117° E.	1	6.1
B–529	3 Feb. 1949	11°44′ N.	118° E.	3	5–8.2
B 551	17 Feb. 1949	11°04′ N.	123°48′ E.	1	6.2
B–574	23 Feb. 1949	12°37′ N.	123°27.3′ E.	1	5.2
B–577	24 Feb. 1949	12°51′ N.	122°47′ E.	1	5.1
B–819	18 July 1949	7°12′ N.	116°12′ E.	1	11.0
B 832	19 July 1949	10°25′ N.	117°46′ E.	4	5–5.8
B–1118	21 Nov. 1949	10°45′ N.	120°40′ E.	3	5.8–7

[1] Distorted.

Five spines are present along the edge of the preoperculum: Two large slender spines at the angle, one small spine on the vertical edge, and two small spines on the horizontal edge. Three small spines are present on a slight crest lying on the surface of the preoperculum. The vertebrae cannot be distinguished at this size in cleared and stained specimens. The urostyle is long and slender and bent slightly upward at the tip.

The pectoral fins are represented by small rounded, poorly developed membranes covering the anterior portion of the abdominal sac, but the ventral fins are absent. Median fins are not present, but they are represented by a continuous median fin membrane extending backward along the dorsal midline from immediately posterior to the pectoral base, around the end of the tail, and forward along the ventral midline almost to the anal opening. Faint vertical striations are visible in the region of the caudal fin.

The body color of formalin-preserved specimens is white. A few small spots of black pigment are scat-

FIGURE 22.—Localities in Philippine waters from which the larvae of *Euthynnus yaito* were collected.

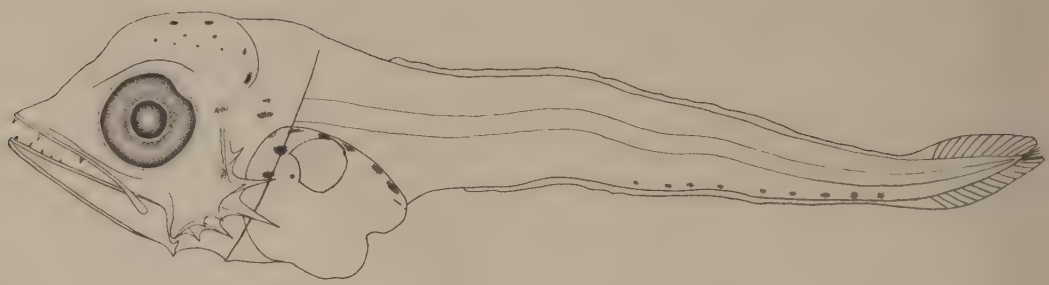

FIGURE 23.—*Auxis* sp. (?), 5.1 mm.

tered over the membrane covering the brain. Several small, faintly marked pigment areas are distributed on the sides of the head posterior to the eye. The peritoneal lining of the abdominal sac has a few, scattered oval areas of black pigment. A series of small black-pigmented areas extends anteriorly along the ventral midline from the region of the caudal peduncle almost to the midpoint of the body.

Only slight changes have taken place in *Auxis* sp. (?) by the time it has reached 6.8 mm. total length (fig. 24). The body has become deeper and heavier. The head is not excessively large in relation to the body and remains truncated posteriorly.

The edge of the preoperculum bears seven spines: Two long slender spines at the angle, two small spines on the vertical edge, and three small spines on the horizontal edge. The vertebrae remain undeveloped. The nostrils are not visible.

The caudal fin is well developed, but the other median fins remain undeveloped. The median fin membrane has become partly degenerate in the region of the caudal peduncle. The pectoral fins remain small and undeveloped, and the ventral fins are represented by minute "buds."

The body color of formalin-preserved specimens is white. The color markings remain the same as in the 5.1-mm. specimen, except that the peritoneum lining the abdominal sac is more heavily marked, and a slight dark pigmentation occurs at the dorsal midline of the caudal peduncle in some specimens.

Several changes have occurred by the time specimens have reached 9.7 mm. fork length (fig. 25). The body remains slender and elongated. The dorsal outline of the body, from the nape to the origin of the second dorsal fin, is flat or slightly concave. The head is large, truncated posteriorly, and the dorsal outline is expanded above the brain. The abdominal sac is becoming somewhat elongated, and the anal opening is moving posteriorly toward the middle of the body.

The wedge-shaped snout is short and pointed, and the slopes of the dorsal and ventral outlines are almost equal. The diameter of the eye is equal to or slightly greater than the snout length. The mouth is oblique, and the tip of the maxillary is at the mid-

FIGURE 24.—*Auxis* sp. (?), 6.8 mm.

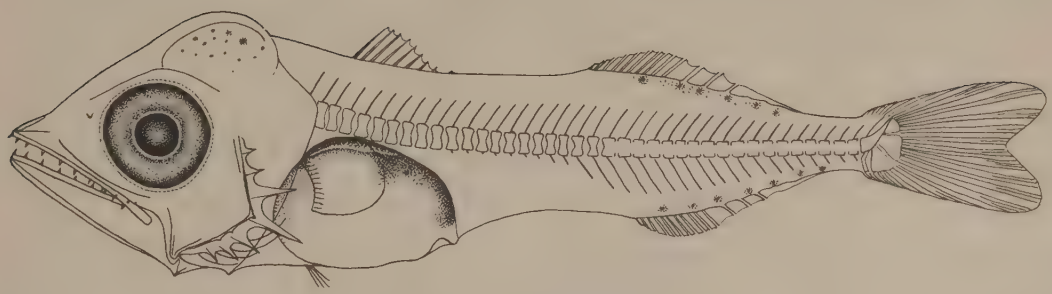

FIGURE 25.—*Auxis* sp. (?), 9.7 mm.

depth of the head. There are 8 to 10 teeth on each side of both jaws The end of the maxillary reaches to a vertical drawn through the posterior edge of the pupil.

The number and position of the preopercular spines remain the same as in the 6.8 mm. specimen. Anteriorly, the vertebrae can be easily seen, but are only faintly discernible posteriorly. The hypural plate is well developed.

The dorsal fin has 9 rays and is separated by a long interspace from the second dorsal, which has 10 rays. The anal fin has 11 rays. Three dorsal and anal finlets can be seen faintly. The median fin-membrane has completely disappeared from the interspace between the two dorsal fins and from the dorsal and ventral midlines of the caudal peduncle. The caudal fin is well developed and slightly forked. The pectoral and ventral fins are present and moderately developed.

The body color of preserved specimens remains white. A few small scattered black-pigmented areas are found on the membrane covering the brain. The abdominal sac is heavily pigmented dorsally with small chromatophores. The posterior portions of the dorsal and ventral midlines are faintly pigmented with an irregular row of small dark spots.

An 11.6 mm. fork-length specimen (fig. 26) is almost identical with the 9.7 mm. specimen. Its general appearance is quite similar to the smaller juvenile forms. There are from 11 to 13 teeth on each side of both jaws. The preopercular spines remain the same. The first dorsal fin, with 13 developed spines, is widely separated from the second dorsal fin which has 16 rays and 7 finlets. There are 18 plus 21 well-developed vertebrae. Only one nostril opening is evident on each side of the snout. The color pattern remains the same as in the 9.7 mm. specimen.

The only other species of larval tuna described in this bulletin with which *Auxis* sp. (?) is likely to be confused is *Euthynnus yaito*. Specimens of *Auxis* sp. (?) larger than 9 mm. fork length can be identified easily by the widely separated dorsal fins which are without a connecting median fin-membrane. The head is of moderate size, truncated posteriorly,

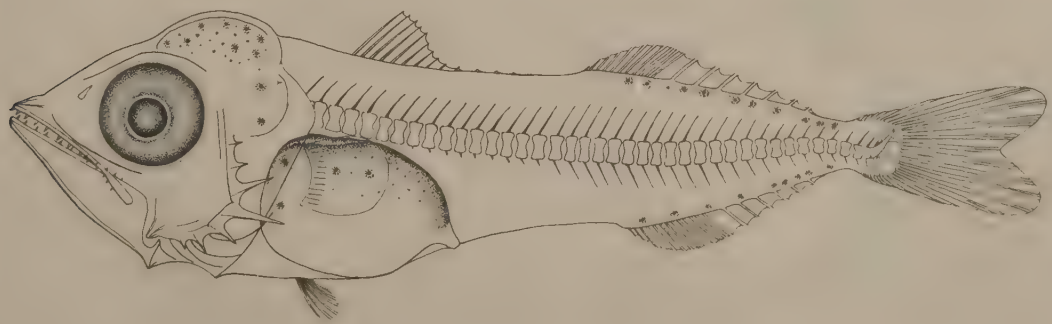

FIGURE 26.—*Auxis* sp. (?), 11.6 mm.

PHILIPPINE ISLANDS
AUXIS Sp.?
LARVAE
TAIWAN
LUZON
MINDORO
SAMAR
PANAY
NEGROS
PALAWAN
MINDANAO
BORNEO
CELEBES
HALMAHERA
115°
120°
125°
130°
20°
15°
10°
5°
0°

while the snout is short and bluntly wedge-shaped. The mouth is oblique, and the tip of the maxillary lies at about mid-depth of the head.

Medium-sized specimens of *Auxis* sp. (?) from 5 to 9 mm. can be distinguished from *Euthynnus yaito* by the more poorly developed median fin-membrane. The later development and slower growth of the first dorsal rays and the characteristic features of the head of *Auxis* sp. (?) have already been discussed. The row of pigment along the posterior portion of the ventral midline is similar in both forms, but it seems to extend more anteriorly on most specimens of *Auxis* sp. (?). The large head and the almost entire lack of body pigment separates *Katsuwonus pelamis* from *Auxis* sp. (?), whereas the large highly developed first dorsal and lack of body pigment defines *Neothunnus macropterus*.

Small examples of *Auxis* sp. (?) are difficult to distinguish from larval *Euthynnus yaito*. The less well-developed median fin-membrane, the short, truncated head, the short, bluntly pointed snout, and a greater number of preopercular spines usually will identify *Auxis* sp. (?). Damaged specimens, or those in which the features are distorted, are often impossible to identify. In *Neothunnus macropterus* of 5 to 9 mm., the head is larger, and no body pigment is present. *Katsuwonus pelamis* is distinguished by the large head, long snout, wide gape, and absence of a row of pigment spots posteriorly along the ventral midline.

The greatest catch of *Auxis* sp. (?) larvae was made during January, February, and March. The collection during the remainder of the year was meager, and these data coincide with those obtained during a study of the public fish market of Batangas, Luzon. Small juvenile *Auxis* sp. (?) begin to appear on the market in late November and are found in increasing numbers until January and February, when they begin to decrease in quantity, and are not found after May. These marketed juveniles were caught in both Batangas and Balayan Bays which are well sheltered. They were captured in fish traps and several types of local nets, both close to the shore and in open water. It is believed that for spawning *Auxis* sp (?) usually prefers protected, more or less shallow areas, fairly close to land. As the research work of the Philippine Fishery Program was conducted primarily on the high seas, and only occasionally in protected waters, it is possible that the collections do not represent the normal distribution and relative abundance of

TABLE 18.—*Monthly catch of larval* Auxis *sp.* (?) *taken in Philippine waters, 1947–49*

Month	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
1947					
October	21				
December	15				
1948					
February	10				
March	18	1	5.5	6	0.33
April	27	4	14.8	4	.15
June	27				
July	25				
August	17	1	5.9	2	.12
September	28				
1949					
January	30	8	26.8	117	3.9
February	43	4	9.3	6	.14
May	38				
June	25				
July	18	2	11.1	5	.28
August	50				
September	35				
October	20				
November	16	1	6.3	3	.19
All	463	21	4.5	143	0.31

TABLE 19.—*Hourly summary of larval* Auxis *sp.* (?) *collected in Philippine waters, 1947–49*

Hour	Total number of plankton tows	Tows with larvae		Larvae	
		Number	Percent	Number	Average catch per tow
0600–0659	26	2	7.6	96	3.70
0700–0759	18	2	11.1	4	.22
0800–0859	19	2	10.5	3	.16
0900–0959	23				
1000–1059	15				
1100–1159	18				
1200–1259	22	2	9.1	2	.09
1300–1359	19	3	15.8	3	.16
1400–1459	21				
1500–1559	16				
1600–1659	31	2	6.4	11	.35
1700–1759	22	1	4.5	4	.18
1800–1859	16	2	12.5	2	.13
1900–1959	21	1	4.8	3	.14
2000–2059	16				
2100–2159	23				
2200–2259	21	1	4.8	1	.05
2300–2359	17	2	11.7	4	.23
0000–0059	18				
0100–0159	13				
0200–0259	21	2	9.5	3	.14
0300–0359	15	1	6.7	6	.40
0400–0459	13				
0500–0559	18	1	5.5	1	.05

FIGURE 27.—Localities in Philippine waters from which the larvae of *Auxis* sp. (?) were collected.

PHILIPPINE ISLANDS
UNDETERMINED TUNA-LIKE LARVAE
TAIWAN
LUZON
MINDORO
SAMAR
PANAY
NEGROS
PALAWAN
MINDANAO
BORNEO
CELEBES
HALMAHERA
115°
120°
125°
130°
20°
15°
10°
5°
0°

this genus. From the collections and data secured from the public market, it appears that the principal spawning activities occur during the winter and that scattered spawning takes place the remainder of the year.

A 4 mm. specimen was assigned tentatively to the genus *Auxis* sp. (?) by Kishinouye (1926). It was captured in a plankton net off Takarajima, Japan, 29°09′ N., 129°13′ E., June 8, 1924. Although the illustration is not available for study, the brief description more closely approaches that of *Euthynnus yaito* than of *Auxis* sp. (?) and, as observed by Kishinouye, it may actually have been *E. yaito*.

The hourly catches are too meager to determine the differences, if any, between the abundance of material in day and night tows. A large sample taken at 0600 to 0630 hours has distorted the true picture of the average daytime catches, although the percentage of successful tows is slightly greater during the day than at night. Only 14 of 250 tows (5.6 percent) were successful during the day; 9 of 212 tows (4.3 percent) were successful at night. Ignoring the single large sample, the average catch of both day and night tows is about the same: An average of 0.11 specimen during the day and 0.09 during the night. The rather inadequate data indicate that the diurnal and nocturnal abundance of larval *Auxis* sp. (?) at the surface is approximately the same.

UNDETERMINED TUNA-LIKE LARVAE

It was impossible to identify a portion of the collection of tuna-like larvae, particularly smaller specimens which were badly damaged or distorted. Beyond the fact that they were tuna-like, nothing could be specifically determined. Neither was it possible at times to identify small isolated specimens which did not possess characters sufficiently well developed to determine their proper taxonomic status. A list of those stations at which undetermined larvae were found is given in table 20 and plotted on figure 28.

TABLE 20.—*Station list of unidentified tuna-like larvae collected in Philippine waters, 1947–49*

Station	Date	Latitude	Longitude	Specimens	
				Number	Size (mm.)
B-22	9 Oct. 1947	8°41′ N.	122°50′ E.	1	4.5
B-32	13 Oct. 1947	9°49′ N.	119°22.5′ E.	1	4.5
B-47	3 Dec. 1947	9°03′ N.	118°58′ E.	6	(1)
B-56	6 Dec. 1947	7°54′ N.	118°51′ E.	7	(2)
B-127	3 Mar. 1948	4° N.	125° E.	1	(2)
B-160	12 Apr. 1948	3° N.	120° E.	1	(2)
B-244	16 June 1948	10°45′ N.	121°48′ E.	1	(2)
B-258	19 June 1948	6°48′ N.	121°26′ E.	1	(2)
B-261	20 June 1948	8°20′ N.	120°50′ E.	1	(2)
B-294	10 July 1948	6°26.5′ N.	120°24′ E.	1	5.0
B. 296	11 July 1948	5°53′ N.	119°23′ E.	1	(2)
B-329	30 July 1948	5° N.	120°30′ E.	1	(2)
B-330	do	4°45′ N.	119°53′ E.	2	(2)
B-338	1 Aug. 1948	1°56.5′ N.	119° E.	1	(2)
B-342	2 Aug. 1948	2° N.	120° E.	1	(2)
B-348	4 Aug. 1948	2° N.	121° E.	15	(2)
B-355	6 Aug. 1948	4° N.	122° E.	1	4.1
B-356	6 Aug. 1948	5° N.	122° E.	6	(2)
B-375	4 Sept. 1948	7° N.	123°49′ E.	3	(2)
B-376	5 Sept. 1948	6° N.	124° E.	1	4.8
B-378	do	5° N.	124° E.	1	5.8
B-383	6 Sept. 1948	5° N.	126° E.	1	4.7
B-384	7 Sept. 1948	6° N.	125°48′ E.	2	(2)
B-388	do	6°44′ N.	125°46′ E.	2	(2)
B-405	13 Sept. 1948	1°08′ N.	124° E.	2	(2)
B-408	14 Sept. 1948	2° N.	123° E.	1	(2)
B-411	do	2°56′ N.	123°03.5′ E.	2	(2)
B-482	14 Jan. 1949	14°30′ N.	119°50′ E.	1	5.0
B-486	22 Jan. 1949	12°42.5′ N.	119°32.5′ E.	2	5.5–6.0
B-487	do	12°59′ N.	119°56′ E.	1	6.0
B-488	do	13°16′ N.	120°21′ E.	4	(2)
B-523	2 Feb. 1949	10°17′ N.	118°06′ E.	1	3.8
B-527	3 Feb. 1949	11°03′ N.	119°03′ E.	5	(2)
B-534	14 Feb. 1949	13°37′ N.	120°47′ E.	9	(2)
B-535	15 Feb. 1949	13°22′ N.	121°27′ E.	2	(2)
B-545	16 Feb. 1949	11°55′ N.	121°50′ E.	4	(2)
B-552	17 Feb. 1949	10°39′ N.	123°42′ E.	10	(2)
B-554	18 Feb. 1949	9°46′ N.	123°14.8′ E.	2	(2)
B-559	19 Feb. 1949	10°23′ N.	124°09′ E.	2	4.7–5.0
B-560	do	10°40′ N.	124°38′ E.	5	4.2–4.6
B-574	23 Feb. 1949	12°37′ N.	123°27.3′ E.	1	6.0
B-577	24 Feb. 1949	12°51′ N.	122°47′ E.	1	5.8
B-661	18 May 1949	21°19′ N.	123°31′ E.	2	(2)
B-680	21 May 1949	17°06.5′ N.	122°36.7′ E.	1	(2)
B-695	24 May 1949	14°52′ N.	122°28.9′ E.	4	(2)
B-718	27 May 1949	15°12′ N.	127°36′ E.	2	(2)
B-730	29 May 1949	12°10′ N.	127°35′ E.	1	(2)
B-823	18 July 1949	8°07.5′ N.	116°07′ E.	1	4.0
B-825	19 July 1949	9°20′ N.	117°03.5′ E.	2	(2)
B-864	1 Aug. 1949	13°45′ N.	117°53′ E.	6	(2)
B-866	do	13°34′ N.	117°07′ E.	2	5.0–5.3
B-967	29 Aug. 1949	9°04′ N.	118°40′ E.	1	4.9
B-996	4 Sept. 1949	9° N.	123°03′ E.	1	(2)
B-1000	5 Sept. 1949	9°31′ N.	122°15′ E.	2	(2)
B-1003	do	10°27′ N.	121°51′ E.	2	(2)
B-1034	15 Sept. 1949	13°07′ N.	124°18′ E.	1	(2)
B-1042	19 Sept. 1949	9° N.	124°39′ E.	1	(2)
B-1046	20 Sept. 1949	8°50′ N.	123°57′ E.	1	(2)
B-1076	17 Oct. 1949	11°25′ N.	126°07′ E.	1	(2)
B-1077	18 Oct. 1949	10°33′ N.	126°26′ E.	1	(2)
B-1080	do	10°55′ N.	128°27′ E.	3	(2)
B-1083	19 Oct. 1949	12°44′ N.	130°12′ E.	1	5.2
B-1110	18 Nov. 1949	11°38′ N.	128°38.5′ E.	1	4.8
B-1111	19 Nov. 1949	11°23.5′ N.	123°20.7′ E.	1	(2)
B-1113	do	11°39′ N.	123°02′ E.	2	4.9–5.1

[1] Damaged.
[2] Distorted.

See footnotes at end of table.

FIGURE 28.—Localities in Philippine waters from which undetermined tuna and tuna-like larvae were collected.

SUMMARY

Within an area of 810,000 square miles the Philippine Fishery Program of the United States Fish and Wildlife Service made 463 larval fish and plankton tows. From these collections, 1,842 specimens of tuna and tuna-like larvae were separated, and the larval forms of 5 genera and 4 species identified: *Grammatorcynus bicarinatus*, *Neothunnus macropterus*, *Katsuwonus pelamis*, *Euthynnus yaito*, and *Auxis* sp. (?). There are 15 genera and 21 species of tuna and tuna-like fishes recorded from Philippine waters, and the larvae of 10 genera and 16 species remain unknown. Until these unknown forms are collected and studied, the specific identification of the larvae of this group will remain a difficult and complex problem.

In spite of the abundance of material collected, many small specimens could not be identified to species. Until a complete series, throughout the size range of each species, is available, accurate determination of the small forms will not be possible. In general, Kishinouye's (1923) taxonomic nomenclature is used in this bulletin, although the tuna and tuna-like fishes may also be classified according to Herre (1950), Berg (1940), or Jordan (1923).

Based upon the seasonal distribution of larvae in the present collections, it appears that the most intensive spawning occurs during December, January, and February, and that June and July represent the period of least spawning. Although it was impossible to conduct periodic reexaminations of any specific area to determine fluctuations in the abundance of tuna-like larvae, six irregularly timed trips to the Sulu Sea helped to confirm the above data. On these trips tuna-like larvae were taken most abundantly during December and January, while June and July were the least productive. Comparison of catch records with surface water temperatures during these trips shows that the greatest number of larvae was taken at periods of the lowest water temperature and the least number was taken when the temperature was high. No attempt has been made in this bulletin to discuss the ecology of the tuna-like larvae, either as a group or as species.

Tows made during the hours of darkness, 1800 to 0600, produced more larvae than those made in daytime, 0600 to 1800. During the day, 87 of the 250 plankton tows made (34.7 percent) were successful, with an average of 1.78 specimens per tow. Of the night tows, 105 of 212 tows made (49.6 percent) captured larvae. The average number of specimens for each night haul was 6.55. A total of 1,395 larvae was collected at night and 447 during the day—or 75.8 percent of the total specimens were taken after dark. Night is not only more productive of specimens, but it seems that larvae are then more widely distributed. It also appears that there is some vertical migration downward during the day and a return to the surface at night.

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